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WMD Forecasting in Historical and Contemporary Perspective

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WMD Forecasting in Historical and Contemporary Perspective

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Section I: Historical Assessments
Synthesis Paper

Proliferation Forecasting: Some Lessons from the Past Record

Introduction

Since the earliest days of the atomic age, efforts to forecast future nuclear proliferation trends and developments have figured prominently in U.S. political-military planning. At that time, the critical question for U.S. planners was how soon the Soviet Union would be able to match American possession of atomic weapons. From the start, the difficulties of accurately forecasting future proliferation developments became clear in the U.S. failure to assess how quickly the first Soviet test would take place. The most accurate possible proliferation forecasting – and its contribution to avoiding proliferation surprises – remains an essential foundation for future U.S. policies to prevent proliferation or contain its consequences. More broadly, credible and accurate forecasting is essential for anticipating and responding across the spectrum of future security-related threats.

This paper reviews a select set of past proliferation-related forecasts. These "historical" forecasts were performed between 1957 and 1990. They addressed nuclear proliferation most prominently but also included forecasts of Soviet strategic forces developments and wider missile proliferation. These forecasts also covered a broad spectrum of sources: de-classified U.S. intelligence estimates, official memos, assessments by "special commissions," think tank reports, and writings by individual experts. Each forecast sought to project future proliferation-related developments as well as the drivers of those trends.

The paper briefly reviews the main features of the forecasts and then presents a series of potential guidelines for future proliferation forecasting efforts based on the record of past forecasts. These guidelines are intended to support ASCO's exploration of options for developing a forecasting capability as part of its threat anticipation mission and in support of the wider threat reduction activities of the Defense Threat Reduction Agency.

The following historical forecasts were reviewed:

1. *Nuclear Weapons Production in Fourth Countries: Likelihood and Consequences*. National Intelligence Estimate, 1957
2. *Development of Nuclear Capabilities by Fourth Countries: Likelihood and Consequences.* National Intelligence Estimate, 1958
3. *1970 Without Arms Control.* National Planning Association, 1958
4. *Likelihood and Consequences of Proliferation of Nuclear Weapons Systems*. National Intelligence Estimate, 1963

5. *Memorandum for the President: The Diffusion of Nuclear Weapons With and Without a Test Ban Agreement.* Secretary of Defense Robert McNamara, 1963
6. *Report to the President by the Committee on Nuclear Proliferation.* Gilpatric Committee, 1965
7. *Nuclear Proliferation Phase II.* Robert M. Lawrence and Joel Larus (eds.), 1974
8. *Soviet Forces for Intercontinental Attack Through the Mid-1980s.* National Intelligence Estimate, 1975
9. *Trends in Nuclear Proliferation, 1975-1995: Projections, Problems, and Policy Options.* Lewis A. Dunn and Herman Kahn, 1976 (prepared for the U.S. Arms Control and Disarmament Agency)
10. *Intelligence Community Experiment in Competitive Analysis: Soviet Strategic Objectives – An Alternative View.* "Team B Report," 1976.
11. *Swords from Ploughshares – the Military Potential of Civilian Nuclear Energy.* Albert Wohlstetter and Harry Rowen (eds.), 1979 (based on a 1976 report for U.S. Arms Control and Disarmament Agency)
12. *The Dynamics of Nuclear Proliferation.* Stephen M. Meyer, 1984
13. *The Dynamics of Nuclear Proliferation: Balance of Incentives and Constraints.* National Intelligence Memorandum, 1985
14. *Missile Proliferation – Survey of Emerging Missile Forces.* Congressional Research Service, 1988.
15. *Nuclear Proliferation in the 1990s: The Storm after the Lull.* Leonard Spector, 1990 (Appendix A to New Threats: Responding to the Proliferation of Nuclear, Chemical and Delivery Capabilities in the Third World, Aspen Strategy Group Report)

Proliferation Forecasting – a Synopsis of the Historical Cases

As reflected in Tables 1, 2 and 3 below, these forecasts relied on a range of analytic methodologies, highlighted a number of key variables, envisaged different proliferation outcomes, and evinced various strengths and weaknesses. No attempt is made here to examine each these past projections in detail.[1] Instead, the discussion that follows focuses on a number of recurring themes. Taken as a whole, these themes provide insight into the potential limitations or dangers to be avoided in forecasting future proliferation – but also wider security – developments.

Nuclear Proliferation Forecasting – The Initial Analyses

Table 1 distills the findings of a series of initial proliferation forecasts carried out in the period 1957-1965. During this period, there was increasing concern about the possible further spread of nuclear weapons beyond the United States (1945), the Soviet Union (1949), and the United Kingdom (1951).

[1] Section II of this report provides detailed summaries.

Table 1. Selected Nuclear Proliferation Forecasts 1957-1965

Study	*Methodology*	*Key Variables*	*Projection*	*Strengths*	*Limitations*
National Intelligence Estimate – 1957	Country case studies – expert analysis	Indigenous technical capability + neighbor's behavior	Widespread proliferation	Provided capabilities baseline; focused on regional spillovers	Both under and overestimated capabilities; technology push too alarmist
National Intelligence Estimate – 1958	Country case studies – expert analysis	Indigenous technical capability + neighbor's behavior/spillover effects	Widespread proliferation; collaboration among existing and new proliferators	Capabilities baseline	Technology push too alarmist; undercut by wild cards
National Planning Association: 1970 Without Arms Control – 1958	Trends analysis and extrapolation	Indigenous technical capability	Widespread proliferation from inexorable technological advances; U.S.-Soviet nuclear arsenals in many 10,000s	Flagged potential dangers	Technology push too alarmist; underestimated role of political-social-economic factors; undercut by wild cards
Secretary of Defense McNamara: Memo on Comprehensive Nuclear Test Ban – 1963	Alternative scenarios	Different nuclear testing limits; spread of nuclear energy to developed and developing countries	Marginal impact of CTBT on proliferation outcomes	Focused on political incentives and disincentives, not only on technological capabilities	Overestimated spread of nuclear energy
National Intelligence Estimate – 1963	Country case studies	Nexus of technology and motivations	Acquisition of nuclear weapons by China – but via plutonium pathway; India's acquisition; lessened fears of very widespread proliferation despite many countries with technical option	Multiple variables vice only technological capabilities; impact of regime initiatives (e.g., eventual non-proliferation treaty)	Over – and under-estimated timing; overestimated spread of nuclear energy; underestimated domestic factors and nation-unique approaches; undercut by wild cards
Gilpatric Commission Report – 1965	Wise Men-Delphi survey	Technology – especially spread of nuclear energy; perceptions of security	On brink of worldwide nuclear proliferation	Focus on security-related variables vice only technological capabilities	Role of domestic factors underestimated; nuclear energy overestimated

The initial proliferation forecasts examined in this historical study used a broad range of methodologies: country case studies; an extrapolation of current technical-military trends; alternative scenarios; and wise-men Delphi survey techniques. Key crossing-cutting themes include:

Warnings of Widespread Proliferation. Many of the early forecasts envisaged increasingly widespread nuclear proliferation. Perhaps most typical, the National Planning Association's 1958 report warned of a world of dozens of nuclear weapon states by 1970. Internal U.S. intelligence estimates were somewhat more restrained but also erred toward projecting possible acquisition of nuclear weapons by many countries. As late as 1965, the Gilpatric report – based on a Delphi methodology – warned of a world on the "brink" of global proliferation and called for specific actions to be taken to prevent that outcome.

Proliferation Drivers. In large part, these early fears of very widespread future proliferation resulted from a "technology push" model of the proliferation process: a projected global spread of nuclear technology would lead to decisions to pursue nuclear weapons. Toward the end of the 1957-1965 period, there was a greater recognition that the spread of technical capability alone need not result in decisions to build nuclear weapons, particularly if policies and actions to prevent proliferation were put in place.

Spread of Nuclear Energy. The spread of technology to produce nuclear weapons was seen by these initial proliferation forecasts as an inexorable by-product of the spread of civilian nuclear technology. The common theme was that as countries began to use nuclear energy for civilian purposes, especially for nuclear power production of electricity, they would acquire technology, skills, and materials that could be diverted into a nuclear weapons program. In that regard, however, virtually all of these forecasts turned out to have exaggerated the use of nuclear power as a source of nuclear energy by other countries. Technical, economic, and other factors all resulted in a far slower spread of nuclear power than anticipated in the late 1950s and early 1960s.

Uncertainty in Estimating the Emergence of New Nuclear Powers. Individual forecasts both overestimated and under-estimated how long it would take individual countries to acquire nuclear weapons. In some instance, this reflected faulty assessment of the future technological capabilities of specific countries. For example, the 1957 National Intelligence Estimate (NIE) assessed that China would not be able to acquire nuclear weapons without major external assistance. Similarly, while the 1963 NIE projected China's acquisition of nuclear weapons, it overestimated how long it would take China to acquire the needed nuclear weapons materials and expertise to do so. By contrast, the 1963 NIE underestimated how long it would take India to emerge as a nuclear weapon state – in part because it misjudged the extent of Indian ambivalence about nuclear weapons, and in part because of "wild cards" (see below).

Focus on U.S. Allies and Friends. One of the primary areas of attention of these early forecasts was proliferation by U.S. allies and friends in Europe. In large part, this focus reflected the emphasis on the availability of indigenous technical capability as a

key proliferation driver as well as the spillover effects from a neighbor's acquisition of nuclear weapons. The initial studies, e.g., the 1958 NIE, also highlighted the impact of U.S. policy – in particular, a U.S. nuclear guarantee through NATO, as a countervailing factor. Indeed, these initial warnings of proliferation partly contributed to new U.S. policy steps to enhance the American nuclear guarantee to key allies.

Reliance on a "Proliferation Mental Model." Sometimes, a mental model or mindset about the proliferation process proved faulty. Again to cite the case of China, the 1963 NIE assumed that China would follow the plutonium production route to acquire nuclear weapons material for a first device. The U.S. Trinity test had used plutonium, as had the first Soviet atomic bomb test. Production of highly-enriched uranium for nuclear weapons also was thought to be beyond China's capabilities at the time. This assumption was proved wrong when analysis of China's 1964 test showed that it had been of a uranium device

Impact of "Wild Cards." The occurrence of unexpected developments sometimes undercut the accuracy of these initial forecasts. India's projected advance toward nuclear weapons proved slower than anticipated by the 1963 NIE partly because of the deaths of critical leaders (Prime Minister J.N. Nehru in 1964 and his successor Lal Bahadur Shastri in 1966) and key bomb proponents (Homi Bhabha, the founder of India's atomic energy program in 1964).

Forecasting Changed the Forecast. To varying degrees, the forecasts became an independent factor shaping the future proliferation outcomes that they were seeking to forecast. By way of example, the 1958 NIE emphasized the importance of a U.S.-NATO nuclear guarantee to reassure Germany. Also, the Gilpatric Report's fears of widespread proliferation gave a push for U.S. efforts to negotiate the NPT.

Nuclear Proliferation Forecasting – The "Second Wave"

India's detonation of a nuclear explosive device in 1974 once again focused U.S. attention on the proliferation of nuclear weapons. In this context, what may be termed a second wave of proliferation forecasts resulted, including studies undertaken directly for the U.S. government. By the 1980s, there had been sufficient past internal forecasts to warrant a National Intelligence Estimate on "lessons learned." Summarized in Table 2, these studies again used a variety of methodologies. Some key themes include the following:

Proliferation Scope and Pace Overestimated. Once again, there was a tendency among the more prominent of these forecasts to overestimate the scope and pace of future nuclear proliferation. The Dunn-Kahn study set out a series of alternative projections of proliferation, ranging from "slow but steady" proliferation to a world of "runaway" proliferation. Somewhat differently, the Wohlstetter-led analysis

warned of what it called a "plutonium overhang," with upwards of 40+ countries having access to nuclear weapons material. This led the authors to warn of potential "exponential" growth in the number of nuclear weapon states. By contrast, in its review of past assessments for lessons learned, the 1985 NIE explicitly noted that earlier fears of overt proliferation had been exaggerated, partly due to a an emphasis on access to technology as the proliferation driver, partly due to a "domino effect" theory assuming many inter-linked proliferation decisions.

More Sophisticated Understanding of Proliferation Drivers. Technology availability continued to figure prominently as a variable shaping future proliferation trends in these studies – and in the case of the Wohlstetter study was the overriding reason for concern about the prospect for widespread acquisition of nuclear weapons. At the same time, these studies reflected overall a more varied and complex assessment of proliferation drivers. Several of them highlighted the interaction of technical and political factors leavened by bureaucratic and scientific momentum as well as domestic politics. The NIE's review of past forecasts acknowledged the role of U.S. non-proliferation policies as an independent variable in its own right.

Table 2. Selected Nuclear Proliferation Forecasts: 1970-1990

Study	*Methodology*	*Key Variables*	*Top Forecasts*	*Strengths*	*Limitations*
Robert Lawrence and Joel Larus, "Nuclear Proliferation Phase II" – 1974	Country case studies – experts from each country	Officially-articulated security doctrines and policy	Some proliferation likely – India, Israel, but not South Africa	Provide insights from country nationals	Too fixed in time – overtaken by events; undercut by wild cards (e.g., Cuban-Soviet intervention in Africa)
Lewis Dunn and Herman Kahn, "Trends in Nuclear Proliferation – 1975-1995" – 1976 ACDA report	Alternative futures	Technical options, political-security incentives and disincentives, bureaucratic and scientific momentum, proliferation shocks	Slow but steady proliferation taken as starting point – but only one of 15+ conceivable alternative futures up to runaway, global proliferation	Concept of proliferation chains; highlighted multiple drivers and more complex proliferation dynamics via alternative futures; focus on dealing with consequences as well as prevention	Too many possibilities set out – no single "most likely"; chain reaction effect over-estimated; undercut by wild cards (e.g., internal political change in Argentina-Brazil)
Albert Wohlstetter and Harry Rowen (eds.), "Swords from Ploughshares" – 1979 (original version in 1976 as ACDA report)	Trends analysis – quantitative estimates of plutonium availability ("overhang") with widespread use of nuclear energy	Spread of nuclear energy; estimates of available plutonium	Emerging access to nuclear weapons material by 40+ countries – danger of exponential growth of nuclear weapon states	Highlighted potential impact of nuclear energy use; baseline of worst case risk	Extrapolation of trends overtaken by events – 1979 Three Mile Island nuclear accident damped nuclear energy use; problems with use of civil plutonium
Steven Meyer, "Dynamics of Nuclear Proliferation"	Quantitative model – with Delphi ranking by experts	Risk factors – technical capabilities, motivations, proliferation impact	Assessed proliferation risk across 36 countries	Summarized large body of country data; provided relative proliferation risk rankings with both technical and motivation factors	Individual experts with varied knowledge of many countries; over- and under-estimated internal factors
National Intelligence Council – 1985	Historical assessment of previous NIEs for lessons learned	Technical capabilities, political motivations, internal factors, non-proliferation norms, impact of U.S. policies	Future proliferation likely to be covert not overt; acquisition by Pakistan	Use of multiple variables; identified lessons to be learned from past assessments	Underestimated technical advances – DPRK, Iraq, Brazil; undercut by wild cards (e.g., A.Q. Khan network)
Leonard Spector, "Nuclear Proliferation in the 1990s: The Storm After the Lull" – 1990	Country case studies by an individual author	Technical capabilities; security motivations; domestic factors	Additional horizontal proliferation; lack of progress on nuclear disarmament threatens Nuclear Non-Proliferation Treaty (NPT)	Comprehensive assessment provided baseline for more detailed country analysis	Undercut by domestic political wild cards (e.g., collapse of Soviet Union apartheid South Africa); limits of single author

Spread of Nuclear Energy Overestimated. Many of these forecasts (most prominently the Wohlstetter-led study) overestimated the global spread of nuclear energy generally, and the use of plutonium as a civilian nuclear reactor fuel more specifically. Once again, there was an assumption of nuclear energy finally "taking off". In good measure, this assumption reflected the impact of the 1973 oil embargo, tightening of global energy markets, and stated plans of many countries to rely more heavily on nuclear energy to generate electricity as well of some countries to use plutonium to fuel breeder and light-water reactors. Such plans did not materialize – due to changing economics, technical problems, and the occurrence of wild cards.

Timing Considerations. In some cases, proliferation forecasts identified future developments that did not come to pass in the period covered by the projection but which have since occurred. While the Wohlstetter study's projection of a world of nuclear-capable states proved exaggerated for its time, it now is acknowledged that many states are acquiring latent nuclear proliferation options. Somewhat similarly, while the Nuclear Suppliers' Group proved very effective in controlling technology from the mid-1970s to the mid-1990s, its effectiveness was dramatically undercut in the past decade by new illicit sources of supply (e.g., the A.Q. Khan network).

Wild Cards Again Affected Outcomes. The occurrence of many different types of wild cards again influenced the extent to which these forecasts proved accurate. The Three Mile Island nuclear power plant accident in 1979 – followed by the far more serious Chernobyl accident in1986 – dramatically undercut public and political support for pursuing nuclear power. Somewhat differently, Soviet-Cuban intervention in Angola changed the political-military context for South Africa's thinking about nuclear weapons, thereby undercutting the Lawrence-Larus forecast that South Africa would not seek nuclear weapons. Domestic political changes in Argentina and Brazil in the mid-1980s also was unanticipated but had significant non-proliferation spillovers. At the end of the period, the collapse of the Soviet Union in 1991 and South Africa's change of nuclear policy were two other wild cards that could not have been anticipated but which shaped proliferation dynamics.

The Forecasts Influenced Outcomes. Once again the forecasts themselves played a part in shaping and reinforcing U.S. non-proliferation policy. Conducted for the U.S. Arms Control and Disarmament Agency in the aftermath of India's nuclear test, both the Dunn-Kahn and the Wohlstetter-Rowen studies contributed to the overall reinvigoration of U.S. non-proliferation efforts in the mid-to-late 1970s.

Proliferation Forecasting – Soviet Strategic Forces and Missile Proliferation

Several other forecasts addressed Soviet strategic forces and missile proliferation. These are captured in Table 3.

Table 3. Selected Forecasts of Soviet Strategic Forces and Missile Proliferation: 1970-1990

Study	*Methodology*	*Key Variables*	*Top Forecasts*	*Strengths*	*Limitations*
National Intelligence Estimate on Soviet Forces for Intercontinental Attack through the mid-!980s – 1975	Quantitative modeling of alternative outcomes	Technological research and development advances; alternative SALT II strategic arms control scenarios	Continued augmentation of Soviet military capabilities – new, more accurate ICBMs; increased force survivability and flexibility; but strategic balance unlikely to be decisively altered	Comprehensive assessment of strategic trends	Overtaken by wild card of Soviet invasion of Afghanistan, resulting in failure of SALT II agreement to enter into force; discounted Soviet strategic culture (see Team B assessment)
Soviet Strategic Goals – "Team B" Assessment -- 1976	Use of outside experts to review in-house assessment; extrapolation from history, strategic culture	Historical evidence – as discerned by Team B members – compared to previous NIEs	Soviet leaders seeking strategic superiority and global hegemony; did not accept mutual assured destruction but were pursuing war-fighting capability; U.S. mirror images – projecting its own assumptions and policies onto Soviet Union	Challenged insider "mindsets"	Team B had its own "mindsets"
'Missile Proliferation – Survey of Emerging Missile Forces" – Congressional Research Service (CRS) -- 1988	Country case studies – technical assessment	Technical capabilities	Country-by-country assessment of future advances of missile programs around the world	Comprehensive survey – overall, accurate in its assessment of country capabilities	Underestimated some capabilities; did not consider internal and external geopolitical factors – vice technology options – as motivating factors

Two key themes recur in this related but distinct area.

The Impact of Mindsets – and Counter-Mindsets. Facing criticism of its policy toward the Soviet Union, the Carter Administration asked a team of outside experts to review past intelligence assessments of Soviet strategic policy and posture. At the heart of this so-called "Team B" assessment was the view that earlier formal estimates had downplayed what the group viewed as Soviet pursuit of nuclear superiority and global strategic hegemony. To the Team B outsiders, these estimates had assumed that the Soviet military and political leadership shared the same strategic goals as the United States – a case of mirror-imaging. At least in part, later revelations after the

end of the Cold War supported this contention that the Soviet political-military elite did not fully share U.S. strategic concepts, especially a commitment to mutual assured destruction as a strategic concept. That said, the Team B outsiders' view equally reflected its own mindset about the Soviet Union, one that exaggerated the extent of these differences and the Soviet readiness to run risks in pursuit of global strategic advantage.

The Impact of Wild Cards. The occurrence of wild cards was again evidenced. In particular, the Soviet invasion of Afghanistan in 1979 led to the U.S. Senate's decision not to ratify the SALT II Treaty, whose ratification was one of the key assumptions of the 1975 NIE on Soviet intercontinental forces.

Proliferation Forecasting – Some Guidelines from the Historical Cases

The review of past proliferation forecasts suggests a series of inter-related guidelines for future proliferation forecasting. These should be considered in the development of forecasting "best practices."

- Don't rely only on a single methodology.
- Assessing technical capabilities is only the starting point.
- Don't forget the intangibles.
- Be wary of extrapolating trends.
- Develop alternative possibilities.
- Don't mirror image.
- Find a way to challenge mindsets and fashions.
- Think about wild cards.

Don't Rely on a Single Methodology. Over the past decades, many different forecasting methodologies have been used, sometimes more rigorously, sometimes less so. No single methodology proved sufficient. This experience indicates the importance of relying on multiple methodologies in seeking to forecast the future scope, pace, and dimensions of proliferation. Looking ahead, no single preferred approach for mixing multiple methodologies stands out. Instead, the particular mix of methodologies chosen may depend significantly on the more specific question at hand. By way of example, assume the goal is to develop a forecast of 2015 proliferation in a given region. Country case studies using a variety of technical, political, and domestic-internal variables would provide a means for developing a baseline. Thinking about possible interactions among country decisions – if not quite proliferation chains – would complement more static one-by-one country assessments. Several different alternative futures could be developed. In turn, this baseline could be assessed against a number of national, regional, and/or global wild cards that could change the projection.

Assessing Technical Capabilities is Only the Starting Point – and Uncertain. Assessing technical capabilities is essential, but only provides a point of departure. Other political-security variables shaping national decisions – and the unique internal dynamics, bureaucratic features, and strategic cultures of specific countries – also must be considered. Moreover, technical capabilities – and especially the time it would take a country to acquire chemical, biological, or nuclear weapons – have proved uncertain. Unfortunately, past experience offers little guidance on whether to err on the side of assuming more rapid advances or less rapid advances – only that forecasting can err in either direction. More recently, technical capabilities have also been affected by proliferation wild cards, including the type of nuclear entrepreneurship typified by the A. Q. Khan nuclear supply network. This, too, suggests the need to recognize the inherent uncertainties involved in assessing technical capabilities.

Don't Forget the Intangibles – Including Proliferation Psychology. Even as past proliferation forecasts moved beyond an essentially "technology push" model of proliferation to focus on the interaction of political-security motivations and technical possibilities, too little attention still was paid to more intangible factors that can affect proliferation decisions. Several of these factors already have been mentioned, including domestic politics, bureaucratic-scientific momentum and national strategic culture. In addition, one further, particularly intangible factor that needs to be considered is what may be termed "proliferation psychology." Usually overlooked, proliferation psychology has many dimensions. At one level, it encompasses unique ways of thinking and acting among senior-most leaders. For example, it is difficult to understand France's pursuit of a significant nuclear weapons capability without taking into account French President Charles de Gaulle's belief in and commitment to restoring France as a great power. Proliferation psychology also reflects national memory, exemplified by continuing public and official Israeli support for nuclear weapons as the ultimate guarantee against another Holocaust. Still other dimensions include perceptions among decision-makers of the utility and usability of WMD, perceptions of the legitimacy and credibility of existing non-proliferation institutions, and more diffuse beliefs about the possibility of avoiding more widespread proliferation.

Be Wary of Extrapolating Trends. Proliferation related trends – political, military, economic, social, and technological – can provide a starting point for proliferation forecasting. However, past trends have sometimes proved short-lived or weaker than anticipated. The best example in proliferation forecasting is the repeated prediction of ever-greater reliance on nuclear energy globally. In that case, economic uncertainties, technical problems, and public resistance fueled by wild cards all short-circuited what seemed an inexorable trend. Sometimes, perceived trends can create countervailing responses on the part of governments, economies, societies, and

individuals. Fear of a perceived trend toward national enrichment and reprocessing capabilities, for instance, led in the 1970s to a U.S.-led agreement on national suppliers' restraint in the export of such capabilities – and may do so again today.

Develop Alternative Possible Outcomes. One of the most important lessons of past proliferation forecasting is the need to think in terms of alternative possible outcomes. Focusing on alternatives provides a check against the types of forecasting uncertainties and unexpected shifts that have been revealed in this assessment. An appreciation of potential alternative outcomes would also provide a more nuanced basis for policy development. In that regard, it would help especially to identify the potential drivers of less desirable outcomes, which in turn would support actions to avoid them. Thinking in terms of alternative outcomes also would help to test existing forecasting assumptions and challenge established mindsets. Thinking in terms of alternative possible outcomes could entail a highly structured alternative futures approach, or could be more informal with an emphasis on more general scenarios.

Don't Mirror Image. Proliferation forecasting also should be attuned to the risk of mirror imaging and thinking that other countries will share U.S. perspectives, concepts, or technical approaches. In practice, this calls for focusing on the unique cultural, psychological, historical, and other features of various states – and for thinking about how these may shape proliferation decisions, choices, and actions. It also calls for a readiness to accept evidence that other countries may be choosing different technical paths than those pursued by U.S. programs. More broadly, as suggested next, there is a need to challenge existing mindsets about the proliferation process.

Find a Way to Challenge Existing Mindsets. Challenging entrenched proliferation mindsets can be done a number of ways. One way is to use a structured analytic approach aimed at making assumptions explicit – and then testing their credibility. Use of formal "red team" methodologies is another approach. A more routine readiness on the part of analysts to revisit their assumptions and conclusions can be encouraged. Also, some combination of these approaches could be built into the proliferation forecasting process.

Think about Wild Cards. The impact of wild cards in undercutting forecasts of the scope, pace, and characteristics of proliferation is one of the most striking features of past proliferation forecasts. Many different kinds of wild cards were revealed: changes in domestic political leadership, deaths of key individuals, military intervention and conflicts, nuclear power plant accidents all were prominent. Thus, it is especially important to build possible wild cards into any approach to proliferation forecasting. One way to focus on wild cards is to ask explicitly what types of unexpected developments could undermine any given baseline forecast. Or a set of wild cards could be identified and their impact assessed. Still another

approach would focus less on possible proliferation outcomes than on the assumptions underlying current expectations about proliferation – and how different wild cards could reinforce or undermine those assumptions.

Concluding Thought

This assessment of historical proliferation forecasts highlights both some pitfalls to be avoided and some guidelines for approaching the challenge of forecasting future proliferation-related threats. As noted above, forecasts can change the future that they seek to project. By energizing and informing policy responses, forecasts can become "self-denying" prophecies, as was the case with the oft-made, but repeatedly exaggerated historic forecasts of very widespread proliferation. So viewed, whether or not a forecast proves accurate is only one test – and in some ways not necessarily the most critical test – of its ultimate utility in informing U.S. policies.

Section II: Historical Assessments - Synopses

Nuclear Weapons Production in Fourth Countries Likelihood and Consequences

National Intelligence Estimate, Washington, D.C.
National Intelligence Council, 1957

Overview

The NIE forecasts proliferation developments from 1957-1967 using a country case study methodology (with an emphasis on technical capabilities as well as potential neighboring country spillover effects). Its technical assessment projected the amount of nuclear weapon material likely to be available indigenously as a key to determining countries of most proliferation concern. It considered the potential role of outside technical assistance as a proliferation accelerator – both in terms of the timing of access to a limited fission capability as well as in jumping to more sophisticated weapons. The emphasis on indigenous technical capabilities underestimated some countries' ability to go beyond limited weapons programs (even without outside assistance), while overestimating the likelihood that some other countries would seek nuclear weapons. (This overestimate proved to be a continuing weakness of technically-weighted country studies.) The study's focus on neighboring country spillover effects served to highlight some potential proliferation spillovers but also overemphasized others. The NIE's emphasis on the potential importance of foreign assistance likely shaped the conceptual approach taken by U.S. officials to preventing proliferation, with an attempt to impede that assistance via international institutions and treaties. It identified the potential impact of technical-political surprises in affecting proliferation, a factor illustrated by the soon-after creation of a new Fifth French Republic under President Charles de Gaulle.

Timeframe Examined

1957 through 1967 (ten years)

Prevailing Context

With regard to the overall geopolitical situation, this estimate was undertaken in the midst of a troubled international political-security environment. During the preceding years, the following political shocks had occurred: the aborted Hungarian Revolution and Soviet invasion of Hungary to put it down; the Suez Crisis with UK-France-Israel invading Egypt – and being forced out when Soviets threatened nuclear war and the United States did not back the UK and France; and France's defeat at Dien Bien Phu in 1954, which led to its withdrawal from Vietnam. Technically, first the United States and then the Soviet Union detonated rudimentary thermonuclear weapons – H-bombs – in 1954. Somewhat differently, the context for this study reflected speculation about which country would become the

fourth nation– after the United States, the Soviet Union, and the United Kingdom – to acquire nuclear weapons.

Methodology: Country Case Studies

The NIE is comprised of a set of discrete country assessments. In making judgments about future trends, the NIE placed considerable emphasis on assessing indigenous technical capabilities and developments among the fourth states discussed. It stopped short, however, of what later came to be termed as the "technology-push methodology" in forecasting proliferation trends. Two technical dimensions that would figure prominently later, however, were not emphasized: access to imported technology and the role of gray market proliferation rings. Instead, in projecting future trends, the assessment focused on whether or not a state could develop a limited arsenal based on its own resources. The country case study methodology also considered motivational and deterrent factors, particularly as to how these factors could affect the timelines for weapon development in each country examined. As part of the case study methodology, possible spillover effects on other countries were considered.

Key Projections/Forecasts

Based on its country-by-country assessment of technical capabilities, this NIE judged that within the period from 1957-1967 up to 10 countries would have the technical capability to indigenously develop first generation fission nuclear weapons with yields of 20-40 kt. The authors based that assessment primarily on each country's access to uranium, overall level of technology development, and civilian nuclear energy programs. In addition, the country studies examined the role of nationalism and alliances in nations' decisions to pursue or not to pursue nuclear weapons. The NIE noted that a technological breakthrough or successful espionage could significantly increase the capabilities of the countries discussed. The NIE assessed, however, that no fourth country would be able to develop more sophisticated thermonuclear weapons without outside assistance.

Technical Assessment:

France

The nation will be able to have a weapons production capability by 1958. It estimated that France would have produced enough plutonium for up to 3 nominal nuclear weapons of between 20-40 kt yield a year. By 1962, France will have the capability to produce enough plutonium for up 50 weapons per year, and by 1967, France will be able to produce enough for 110 nuclear weapons annually.

Sweden

Sweden would not be able to produce enough plutonium for a nuclear weapon until 1961. By 1964, it would be able to produce enough plutonium for approximately 10-20 to 40kt weapons annually and by 1967, Sweden would be able to produce enough for the production of up to 35 weapons a year.

The NIE predicted that French and Swedish decisions to produce nuclear weapons would not automatically spark immediate nuclear weapons production efforts in other Western European States. However, it might motivate others to call for a jointly developed pool of weapons for a common defense. According to the NIE, Switzerland may also consider independent development if this happens.

Canada
The nation was projected to have the capability to support the production of plutonium for about 35 weapons per year by 1965. (Canada, however, had decided not to pursue nuclear weapons over a decade prior, in the late 1940s.)

West Germany
The country would be able to produce nuclear weapons at the end of the ten-year study period, if it remained totally dependent on its own low-grade uranium ores. If West Germany had access to "high-grade" uranium ores, it could produce nuclear weapons within five years.

Other European countries of concern included Belgium, which the NIE estimated could begin a nuclear weapons program by 1967 with no external assistance. Without extraordinary efforts and assigning the highest priority to a weapons program, Italy would not be able to develop a weapon within a ten-year period. Switzerland, Norway, and the Netherlands would require unrestricted access to uranium supplies or spent fuel from reactors to develop nuclear weapons within a ten-year period. Czechoslovakia, East Germany, and to a lesser extent, Poland were thought able to develop a program based on their uranium resources, but also were seen to be at the early stages of nuclear energy development.

Elsewhere around the globe, Japan was thought technically capable of producing nuclear weapons within 10 years, if given unrestricted access to uranium supplies or if it was able to exploit recently reported uranium deposits to fuel its nuclear reactors. India was seen as unable to develop a nuclear weapons program within the ten-year period without extraordinary efforts and assigning the highest priority to a weapons program. The NIE assessed that in comparison to the above countries, the PRC and Australia possessed fewer of the resources required to develop nuclear weapons and therefore would require major external assistance. Israel was seen to be in a comparable situation. The NIE noted however, that these countries were obtaining assistance from external sources and had already begun nuclear energy programs.

Other Major Conclusions and Unique Dimensions

Motivations
With regard to the motivations that each country may have to acquire a nuclear weapons capability, the NIE highlighted the role of prestige in France's pursuit of nuclear weapons as

well as the potential spillover effects of nuclear weapon acquisition by neighboring countries, e.g. the impact of France's development of nuclear weapons on West Germany's incentives to develop its own nuclear program. The NIE estimated that if the United States agrees to provide nuclear weapons to Western European countries (e.g., as eventually occurred under dual-key arrangements), this step could provide an alternative means of enhanced deterrence for these countries at least in the short term. Domestic political-regime changes were identified as a possible surprise that could affect proliferation.

Other Judgments

One of the major conclusions and unique dimensions of the study was the assessment that up to 10 countries could develop nuclear weapons programs capable of producing 20-40kt nuclear weapons while relying solely upon indigenous resources. At the same time, the NIE was skeptical about the ability of a fourth country to develop more than a limited nuclear weapon system without outside assistance. Disarmament agreements were not seen to be a deterrent to the longer-term development of nuclear weapons by the fourth countries considered.

In turn, the NIE estimated that fourth country weapon development would neither reduce reliance on security alliances nor would it increase the possibility of outright war. However, more fourth power nuclear weapons development could reduce a nation's susceptibility to Soviet pressure and might even lead these countries to assert their independence from Western alliances.

The NIE estimated that the Soviets would not be overly concerned if a fourth country obtained nuclear weapons, but that the Soviets might find ways of taking advantage of assertions of independence by the United States' Western allies in an attempt to worsen U.S. relations with these nations. On the critical question of how the Soviet Union would respond to German acquisition of nuclear weapons, it was judged that the Soviet Union would not attack westwards. Indeed, it was judged that the Soviet Union might be prepared to accept a regional nuclear weapons program for Western Europe.

More broadly, the NIE also concluded that disarmament agreements could offer a means to help contain proliferation incentives in some important countries.

Assessment

Which aspects of the study stood the test of time (i.e. came true)?
Which aspects have not?

France

Prestige considerations will lead France to become the "fourth" nuclear power.

Result: France tested a nuclear weapon in 1960. At the same time, prestige alone cannot provide a sufficient explanation for France's continuing commitment to acquiring a serious nuclear force posture. Rather, a political upheaval leading to Charles de Gaulle's assuming the presidency of the new Fifth Republic and memories of France's 1940 defeat by Germany as well as U.S. failure to support it at Suez were critical drivers of an expanding French program.

China

Communist China would require major foreign assistance to acquire nuclear weapons in 10 years.

Result: Neutral or wrong. Most analysts believe that China received some limited assistance from the Soviet Union, but undertook most of its weapons development activities indigenously. Without outside assistance, China also proved able to test a thermonuclear weapon in 1966, thereby jumping from a limited to a more sophisticated capability. In 1964, during the ten-year forecast period, China conducted its first test without assistance.

India

If China acquires nuclear weapons, then Indian opposition to pursuing an indigenous program may fade.

Result: China's 1964 nuclear weapon test did provide a major impetus to India's pursuit of a nuclear weapons capability.

Japan

Within the next five years (1957–1962), Japan will take initial steps to build a nuclear weapons program independent of U.S. assistance. A Japanese nuclear weapons program will not affect Soviet policies unless the Chinese demand support of their own nuclear weapons endeavors.

Result: Japan did not develop nuclear weapons, partly because of domestic factors and partly due to the American alliance connection.

Canada

If fourth countries obtain weapons and the United States does not provide Canada with air defense, then Canada too will seek its own nuclear weapons.

Result: The North American Air Defense Command (NORAD) was created in 1958 to organize U.S. and Canadian air defense cooperation. Along with wider defense cooperation with the United States in NATO, NORAD reinforced Canada's earlier decision to not to pursue nuclear weapons.

Israel
Israel will attempt to acquire nuclear weapons if it can obtain access to a source of nuclear weapons material.

Result: With assistance from France (provision of the Dimona research reactor and heavy water for that reactor's operation) and the United Kingdom (heavy water), Israel completed the first stage of a nuclear weapons program, R&D, by 1966. On the eve of the 1967 Six-Day War, it may have assembled its first nuclear weapon.

Soviet Reactions
It is unlikely that the actual initiation of fourth power production [nuclear weapons development] in a non-Communist state would alter Soviet estimates of Western intentions or Soviet policies. Moscow would probably accommodate itself to a regional nuclear weapons program of Western European countries.

Result: French acquisition of nuclear weapons did not appear to alter Soviet threat analysis or cause it to attack the West.

In the next 10 years, the Soviet Union will not give Czechoslovakia or East Germany nuclear weapons. Subsequently, these two countries may work to develop indigenous programs.

Result: Unlike some of the more independent East European countries (e.g., Romania and Yugoslavia), neither country ever pursued nuclear weapons.

U.S–UK nuclear cooperation will be seen as a threat by the Soviet Union, leading Moscow to react.

Result: After the United Kingdom's test of a thermonuclear weapon in May 1957, the United States and the United Kingdom initiated a program of bilateral nuclear weapon cooperation. Soon thereafter, in September 1958, the Soviet Union strengthened its alliance with China against the United States, while Soviet Premier Khrushchev stepped up pressures against the Western outpost in Berlin.

Did the particular methodology used influence what the study "got right" and what it "got wrong"? How replicable is the methodology? Can it be employed by others?
Country-by-country assessments – including an emphasis on spillover effects on immediate neighbors – remain a "core methodology" of proliferation forecasting. The NIE's heavy focus on indigenous access to resources (uranium) and technological inputs may have contributed to the NIE's underestimate of some countries' abilities to develop more sophisticated nuclear weapons (e.g., China) as well as its overestimate of some countries' likelihood of pursuing a more limited nuclear weapons capability (e.g., Japan). At the same time, the study's emphasis on spillover effects did rightly highlight some of the proliferation pressures that resulted in the 1957-1967 period (e.g., China-India), even though it

exaggerated the prospects for others (e.g., France-Germany). Finally, technical opportunities alone cannot adequately explain the nuclear weapons program of the newly formed Fifth French Republic. For that, the importance of "regime change" (one of the NIE's surprises), historic memories of past defeats, and perceived abandonment need to be considered.

Was the study influential in some way? If so, how and why? What factors led decision-makers to take notice of it?

The NIE's emphasis on the potential importance of outside assistance to nuclear weapons programs most probably contributed to U.S. support for the soon-to-be created International Atomic Energy Agency and its responsibility to safeguard peaceful nuclear cooperation. Over the longer term, it is likely that the NIE helped shape the conceptual thinking that contributed to the ban under Article I of the Treaty on the Nonproliferation of Nuclear Weapons (NPT) on such assistance in the manufacture or acquisition of nuclear weapons. Its technical projections also likely heightened concern about future proliferation. At the same time, its warnings that U.S. transfer of nuclear weapons technologies to fourth powers would be perceived as a threat to the Soviet Union did not prevent either U.S.-UK nuclear weapon cooperation or the broader set of U.S. dual-key nuclear sharing with its NATO allies. In both cases, the relative influence likely reflects the broader policy interests perceived to be at stake.

Was the study itself influential in changing the course of events, (i.e., did policy intervention result in some aspects of the study being proven wrong)? Or did other external factors change the outcome?

The study recommended that disarmament agreements be pursed as a short-term solution to contain fourth countries' proliferation aspirations. Along with other actions, the eventual negotiation of the NPT did contribute to containing proliferation pressures in some of the countries in question.

1970 Without Arms Control

In Special Project Committee on Security Through Arms Control, Washington, D.C.
National Planning Association, 1958

Overview

This study is a three-section nongovernmental report that forecasted what weapons and weapons systems (with particular emphasis on nuclear weapons) would likely be developed in the following twelve years. In so doing, it explored the effects of nuclear war and weapons technologies. The report's methodology entailed an assessment of technology trends and an extrapolation of future technology-driven developments. Its projection of the future was based on the assumptions that no arms control agreements would be reached in the timeframe examined and that the United States and the Soviet Union would compete technologically in development and deployment of new weapons. Its overall purpose was to inform political leaders and the public of the perils that were ahead, should the arms race continue unabated. As such, it was part of the intellectual ferment that accompanied the development of the concept of arms control. It also helped to lay the groundwork for some of the initiatives of the Kennedy Administration, including some actions (e.g., on nuclear force posture, command and control, and nonproliferation) that made the report's more pessimistic forecasts a self-denying prophecy.

Purpose and Objectives

The purpose of this study is to provide greater awareness of current developments to increase support for the negotiation of arms control agreements.

Timeframe Examined

1958 through 1970 (twelve years)

Prevailing Context

The Cold War was at its height and the destruction of World War II was still fresh in the minds of political and military analysts. The Soviet Union had recently used military force to put down the Hungarian Revolution (1956), while Soviet Premier Khrushchev was threatening to block Western access to Berlin. The Soviet Union had also launched Sputnik in 1957 and was claiming to be deploying a large number of intercontinental ballistic missiles. At the same time, NATO was solidifying, while Western Europe had begun its process of unification with the entry into force of the Treaty of Rome and the establishment of the European Atomic Energy Community in January 1958.

Regarding proliferation, there were only three nations with atomic weapons capabilities: the United States, the Soviet Union, and the United Kingdom. France was pursuing nuclear weapons but would not test a device until 1960. China was presumed to be seeking nuclear weapons but was further behind. Popular opposition to nuclear testing was starting to take root, particularly in the United Kingdom which had a very strong anti-nuclear movement.

Methodology: Technology Trends Analysis and Extrapolation

The NPA Special Project Committee analyzed ongoing technological and weapon-system trends, with an emphasis on technology-push to explain political-military outcomes. Their report begins with a baseline analysis of then-current advanced weapons systems in the United States and the Soviet Union, divided into types. Across each of these types of weapon-systems, future technology possibilities were identified. Past rates of technological development (wherein it had taken approximately 10-15 years from the inception of a new weapons system to its operability) were superimposed on current weapons trends to project the characteristics of the Cold War arms race by 1970. In passing, a closely related technology-push methodology was used to project the future global spread of nuclear weapons.

Key Projections/Forecasts

Prospects for Proliferation:

Though the principal focus of this report was not on which countries would next go nuclear but on the development of new weapons systems, characteristics, and concepts, the report did set out certain judgments about prospects for proliferation. Specifically, it expressed concern that many states without nuclear weapons would acquire them within 5-7 years: namely Canada, Sweden, Belgium, East Germany, Czechoslovakia, China, Japan, India, Switzerland, Italy, and West Germany. Three paths were identified that a country might employ to go nuclear: 1) military assistance from a nuclear power; 2) diversion of peaceful nuclear technology for military purposes; and 3) independent development. The most rapid path was assessed to be through bilateral assistance, with the report citing on-going negotiations between the United States and the United Kingdom as a precedent (though the United Kingdom had tested its initial nuclear device in 1951 without any outside assistance.)

Technical Trends and Developments:

Nuclear Weapons

It was predicted that nuclear weapons would become smaller, lighter, and more useable. Nuclear warheads would become available for many different tactical uses, including air-to-ground missiles, ground-to-ground missiles, artillery, anti-submarine weapons, and mines. The development of suitcase-sized nuclear weapons for sabotage or psychological warfare was anticipated. The authors clearly assumed that the future role of nuclear weapons would be for use in conflict as opposed to serving as a strategic deterrent. In that regard, however, the authors stressed the risks of fallout and dangers that nuclear weapons use would backfire: both on the user and neutral countries.

Aircraft and Submarines

The authors predicted that military aircraft would become faster, perhaps with the development of a hybrid spaceship (rocket) and aircraft, which would be able to evade enemy air defenses. However, the role of aircraft was seen to be largely dependent on the

skills of the pilot and likely to be used primarily for reconnaissance and navigation. Aircraft were seen to play a smaller role in future wars, being somewhat displaced by missiles in attack scenarios.

The authors also predicted that submarines and related technology would undergo great strides in their development. They foresaw the growing importance of nuclear powered submarines capable of launching nuclear-tipped missiles from hidden locations near the enemy's territory. They also estimated that submarine navigation would be improved as well as advances in sonar detection systems. Other possibilities for under-water military equipment were seen to include submersible aircraft carriers and missile launch platforms, which would be towed into place.

Missiles

The report projected that long-range missiles would undergo improvements in targeting, fuel quality, simplicity of detonation, and re-entry speeds. Rocket fuel might even be replaced with nuclear power. Missiles deployments were seen to have two options: either highly mobile or stationary and hardened. It was estimated that stationary launching sites would prove to be more costly, as their location could be detected by the enemy, and thus would require more hardening and concealment. Should this path be taken, launch sites would likely be self-contained entities, so as to maintain the possibility of a retaliatory strike even after the severe damage of an adversary's first strike.

Space based systems

The study argued that the advantages of space-based weapons were uncertain. However, satellites were seen to have uses for weather forecasting and inspections should an arms control agreement be reached. It was envisaged that further technological developments were needed (but could be expected) to harness power from the sun for satellites to improve telemetry (long distance radio transmissions) and reduce the size of recording equipment to enable information to be sent back to earth. There was concern that a potential for national claims on land in space (i.e., the moon) could lead to outer space wars and weapons being developed for the purpose of counterbalancing the other country's weapons. (The study also warned that science and technology would advance to the point that governments could use weather control as a weapon.)

Toxicological warfare

Toxicological warfare was stated to include chemical, biological, and radiological warfare. Chemical warfare (CW) was assessed to have limited use because delivery systems were weak and the effects of CW agents were slow. Biological warfare (BW) was seen as potentially very useful, as the agents employed would be generally self-replicating and could in theory destroy human life, animals, or crops of an enemy nation. BW agents would work well in a covert attack or act of sabotage, but would be useless for defense since the effects of the agent could easily backfire onto non-target populations. BW was seen to be somewhat useful for retaliatory or genocidal purposes: in the latter case, most probably by a dictator against his

own people. The study also judged that delivery systems for CW and BW were still underdeveloped and the causes of infectivity and virulence (in BW agents) were yet unknown.

Radiological warfare (RW) was seen as a good method for leaving structures in place, while blocking access to and use of the structure by humans who would naturally try to avoid contaminated locations. However, for RW to be most effective, the half-life of the radioactive material would have to be carefully selected. It would need not to contaminate the target for too short of a time (as it could fall back into enemy hands) nor for too long of a time (as it would become useless to the attacker). Thus, RW was seen as having a mine-like purpose, limiting the access of enemies to a territory. But then it would naturally disintegrate so as to simplify cleanup and re-use of the territory in question. Delivery systems for RW could potentially be radioactive dust dispersed by plane or high-radiation nuclear weapons being detonated at a precise time and place, and under the right weather conditions, so that the resulting fallout would contaminate a target area.

Other Major Conclusions and Unique Dimensions

Reaction Time

The report estimated that the reaction time for launching nuclear weapons would be greatly reduced. Reduced reaction time would increase the probability that mistakes could cause an accidental nuclear war – either with tactical nuclear weapons or longer-range ballistic missile systems. Furthermore, reduced reaction time would mean that the decision to fire or not to fire a nuclear weapon would likely be delegated to diverse command posts, taking away from presidents and parliaments the power to decide whether or not to engage in nuclear war. The more people with this decision-making capacity, the more likely it was estimated that mistakes could be made.

Massive Retaliation

With every advance made in weapons technology, either for defensive or offensive purposes, the enemy nation was assumed to respond in kind. This action-reaction process, the study argued, had led to the U.S.-Soviet arms build up. The study estimated that each Soviet missile site would need to be attacked with between 2-26 missiles in order to assure 90% destruction. Thus, stockpiling enough missiles for a massive counteroffensive should not be a strategic goal in the 1960s, as the build up would simply get out of hand. Instead, the goal should be to have weapon systems which by guaranteeing retaliation would assure that no attack occurred in the first place.

Diplomatic Negotiations

Negotiations for arms control were determined to depend on the political will of the leaders of both the United States and the Soviet Union. The report urged that negotiators be kept abreast of technological developments so that they could focus any potential negotiations not only on the weapons that existed at the time but also on negotiations concerning future

weapons systems. Doing so would guarantee more informed diplomatic relations and longer-lasting agreements.

Assessment

Which aspects of the study stood the test of time (i.e. came true)? Which aspects have not?

Projections of proliferation
Although its analysis of which countries would develop nuclear weapons systems was not the main purpose of the report, those predictions proved far off the mark. The scope and pace of proliferation was far less than the study's forecast. Virtually all of the countries identified as future proliferators in the report chose not to acquire nuclear weapons. At the same time, the study underestimated China's nuclear drive and failed to identify a number of other countries as potential proliferators, including India, Pakistan, Israel, and South Africa. (For a brief discussion of why the report's forecast proved so wrong see below).

Projections of technical trends
Many, but not all of the study's technical projections proved relatively accurate. Its projections of military doctrine and concepts proved more mixed in terms of accuracy. Consider some examples.

Nuclear weapons
Smaller, lighter, more usable weapons with reduced radioactive fallout would be developed.

Comment: Tactical nuclear weapons were developed, although they still have not been used and have been the target of arms control negotiations.

Aircraft and submarines
Aircraft would be increasingly displaced by missiles as attack platforms, while submarine technology would be used in many ways other than traditional submarines.

Comment: Aircraft have remained a primary tool in most wars since 1958. Submarines have emerged as a critical platform for missile launch but not for the other purposes envisaged.

Ballistic missiles
Improvements were forecasted in targeting, fuel quality, simplicity of detonation, re-entry speeds, and launch sites.

Comment: Virtually all of the technical advances envisaged took place over time.

Space based systems
Multiple uses for satellite systems were forecasted as well as the possibilities of conflict in outer space and the development of space-based weapons systems.

Comment: The results were mixed. Technological developments have improved imaging and transmission methods. Also, satellites are now widely used for weather and reconnaissance purposes. Weapons, including nuclear weapons, were not deployed in space. Ultimately, space a field of international and scientific collaboration, rather than a location for hostilities between nations.

Toxicological warfare
As described above, the study projected that CBR weapons would have limited utility, while radiological weapons could prove promising.

Comment: During the period covered by this study, there was considerable U.S. and Soviet investment in chemical weapons. Similarly, during the period 0f 1958-1970, both countries invested heavily in biological weapons. The Soviet Union probably remained more convinced than the United States of the military utility of both chemical and biological weapons, particularly toward the end of the period in question. Radiological warfare proved less attractive to either Cold War adversary during this period. Later, the United States would seek unsuccessfully to deploy enhanced radiation nuclear weapons in Europe.

Reaction time
The study envisaged greatly shortened nuclear reaction time with the delegation of the power of firing a nuclear missile into the hands of military commanders, rather than the president or his Soviet counterpart.

Comment: Reaction times did continue to shrink greatly. Some delegation of launch authority also appears to have occurred initially in both the United States and the Soviet Union. Both countries put in place technical and procedural means to ensure effective control at the highest levels of nuclear decisions.

Arms build up
It was forecasted that without any arms control agreements, the number of nuclear warheads could run into the millions. This was seen to be especially true if the United States and the Soviet Union chose to proceed with a strategy of preparing for massive retaliation against missile launch sites, rather than against cities.

Comment: The numbers never reached anywhere near the projected levels but still measured in the tens of thousands on each side at the height of the Cold War.

Did the particular methodology used influence what the study "got right" and what it "got wrong"? How replicable is the methodology? Can it be employed by others?
This study's methodology of technology extrapolation contributed directly both to what the study got right and what it got wrong. At the same time, its technology-driven approach meant that the impact of important political-social-cultural variables in shaping the outcome of U.S.-Soviet competition was overlooked. Here too, wild cards played a part.

On the one hand, the study's look back at past rates of technology change as a means to project future technological possibilities led it to correctly identify many key trends that shaped the U.S.-Soviet military competition, from the development of smaller, lighter nuclear weapons to satellite surveillance from space.

Even in terms of its projections of future technological possibilities, its technology-driven assessments exaggerated some developments, e.g., from the decline of manned aircraft to the build up of nuclear forces to truly astronomical levels. Moreover, its emphasis on technological possibilities underestimated the role of political, social, economic and other policy considerations in shaping what came to pass between 1958 and 1970. All of those factors interacted to confound, for example, the study's projections of vast nuclear weapon numbers, delegations of nuclear decision-making, and war in outer space. The impact of the 1962 Cuban Missile Crisis – a wild card – also cannot be underestimated in explaining the ultimate pattern of U.S.-Soviet military competition or the aftermath of the crisis, the fledgling cooperation to contain the risks of nuclear weaponry. (As discussed below, some of the study's projections also helped trigger governmental actions, thereby making it partly a self-denying prophecy.)

The limitations of the study's methodology are most evident in its predictions of widespread proliferation. As with other technological assessments, it was assumed that technology availability was the main impediment to developing nuclear weapons. Consistent with the extrapolation of past technology trends, it also was assumed that over time a growing number of countries would be able to – and then would – acquire nuclear weapons. But this technology-push approach has repeatedly been proven too limited by the decisions of technologically capable nations (Sweden, Japan, and West Germany) not to develop nuclear weapons. In turn, by not focusing on the full set of political-security motivations, the study underestimated the nuclear proliferation potential of less technologically advanced countries.

This type of technology assessment can be replicated to forecast future technology developments – and indeed, has been a staple of future forecasts. But because it does not take into account political, security, economic, social, cultural, and many other "soft" factors, it needs to be complemented by other methodologies.

Was the study influential in some way? If so, how and why? What factors led decision-makers to take notice of it?

The report played an important part in the development of the new concept of arms control, which was beginning to take shape in the late1950s and early 1960s. Its technology projections highlighted a number of problems that were already beginning to figure prominently in the thinking of the defense and foreign affairs communities inside and outside of government (e.g., on nuclear command and control) limiting the dangers of military-nuclear competition in space, preventing proliferation, and generally avoiding a runaway arms race. In addition, its calls for communications between diplomats and scientists and for bringing scientific expertise to bear on future arms control negotiations directly contributed to the thinking that went into the creation of the Arms Control and Disarmament Agency in the Kennedy Administration. That new agency set out to bring into the government highly-trained technical experts to provide the type of support to U.S. negotiations being proposed in the study.

Was the study itself influential in changing the course of events, (i.e., did policy intervention result in some aspects of the study being proven wrong)? Or did other external factors change the outcome?

The report was influential in changing the course of events. Indeed, it was designed precisely with the hope that it would be proven wrong. Its projections of future dangers led U.S. policymakers to take actions aimed at ensuring that those dangers did not come to pass – whether it was very widespread proliferation (from pursuit of nuclear security guarantees to NATO allies to negotiation of the NPT); vast deployments of nuclear weapons (pursuit of survivable nuclear forces leading to nuclear arms control talks), delegations of nuclear control and decision-making (technical command and control arrangements as well as ensuring survivable nuclear postures); or weaponization and conflict in space (the Outer Space Treaty). Finally, as already suggested, the 1962 Cuban Missile Crisis was an external wild card factor that also confounded the more pessimistic projections of the National Planning Association's report and helped to energize the use of arms control that the authors were seeking.

Development of Nuclear Capabilities by Fourth Countries: Likelihood and Consequences

In National Intelligence Estimate. Washington, D.C.
National Intelligence Council, 1958

Overview

This forecast's methodology relied on the analytic judgments and experience of its study team, informed undoubtedly by intelligence information. Reflecting the international political-military context, its discussion of potential disincentives included the impact of a U.S.-Soviet agreement to ban nuclear testing in pressuring "fourth" countries not to seek nuclear weapons. Particular attention focused on China's pursuit of nuclear weapons. That said, the forecast reflected the mindset of the 1950s; its estimate of China's capabilities assumed Soviet cooperation and did not foresee the Sino-Soviet split (although that split was already commencing). The estimate explored possible collaborative nuclear weapons programs or activities among different sets of European countries. For the most part, the NIE reflected an alarmist assessment, especially when one views its emphasis on the technical capabilities countries would have to acquire in order to develop nuclear weapons. This derived partly from its strong technology-push methodology. At the same time, the study's alarmist nature contributed to U.S. efforts to prevent the more extreme projections from coming to pass – particularly at this stage by moving ahead with dual-key nuclear cooperation with key European allies.

Authors

CIA with participation from analysts at the Department of State, Army, Navy, Air Force, Joint Staff, and the Atomic Energy Commission.

Commissioned By

This report was submitted and commissioned by the Director of Central Intelligence.

Purpose and Objectives

To estimate the capabilities and intentions of "fourth countries" in terms of nuclear weapons development and determine how it affects U.S. interests.

Timeframe Examined

1958 through 1968 (ten years)

Prevailing Context

This study was conducted at a time when some states were seeking nuclear weapons, fuel cycle capabilities, and delivery systems. Within the document, there tends to be a high level of concern regarding the possibility of states pursuing nuclear weapons programs. With regard to the overall geo-political context, this study was conducted in the aftermath of the Soviet launch of the first earth-orbiting satellite, *Sputnik* as well as somewhat earlier, the

Soviet use of military force to end the Hungarian Uprising (1956) and the Suez Crisis (1956). This period also was characterized by an overall intensification of Cold War competition that would lead, at the end of 1958, to a U.S.-Soviet Crisis over Berlin, testing the credibility of the United States and the NATO alliance.

Methodology: Country Case Studies

Drawing on qualitative understanding and professional expertise on specific countries, a team of analysts assessed fourth countries' nuclear proliferation activities. They assessed motivators, disincentives, and security alliances that might influence a state's nuclear decision-making process. Particular attention was focused on technical options as well as the spillover effect of proliferation in one country on nearby neighbors. The authors also assessed how the development of nuclear weapons programs would impact the international security environment and U.S. interests. This resulted in projections of potentially available fissile material for a weapons program, in effect, using a technology-push approach. After the leaders of the intelligence community determined the research topic, the research was delegated to the appropriate agencies for further analysis.

Regarding the report's structure, it begins by briefly stating the issue and then lists its conclusions. An executive summary and tables offer judgments on when specific fourth countries could develop nuclear weapons. The main body of the report is a country-by-country analysis of each fourth country's capabilities, intent, and external determinants.

Key Projections/Forecasts

Proliferation Drivers

The key motivators for the acquisition of nuclear weapons are described as the desire for national prestige, pursuit of military capabilities that may be used militarily or politically in local conflicts, a belief that the development of nuclear capabilities is the most efficient form of defense, the desire to buttress a neutral position, and the desire of U.S. allies to acquire enough military power to exercise some degree of deterrence against the Soviet Union. In terms of motivations to acquire a nuclear weapons capability, the authors state that all fourth countries share aspirations for greater national prestige. Domestic incentives are also seen to play a role in their motivations to pursue nuclear weapons. France's case is cited to emphasize the role of national support in facilitating the pursuit of nuclear weapons.

In terms of disincentives to the production of nuclear weapons among U.S. allies, the inhibiting factors were seen to include the risk of a breakdown of relations with the United States and technological challenges associated with the manufacture of a functional weapons system. In the study, the authors forecasted that U.S.-U.S.S.R. agreement on a nuclear test ban would result in pressures on other states not to test nuclear weapons.

Regions/Countries of Greatest Concern

The regions of greatest concern reported in the NIE were the Soviet Bloc countries, including China (prior to the Sino-Soviet split, China was seen as a member of the Soviet Bloc). The study also assessed that France, Sweden, Canada, West Germany, and the Western European Union (WEU) would be the most capable of producing a substantial nuclear deterrent.

Specific Weapon Types (N, B, C, Delivery Means)

Bombers and missiles were seen as the likely delivery vehicles. As referenced in the study, Intercontinental Ballistic Missiles (ICBMs), armed with a megaton warhead, were considered to be the test of a substantial nuclear deterrent posture.

Acquisition Patterns/Trends

This study focuses on the indigenous capabilities of states to pursue independent programs, the development of nuclear weapons programs through foreign assistance programs, and possible regional efforts such as the France-Italy-Germany or WEU.

Deterrence and Employment Concepts

It is presumed that the possession of nuclear weapons could enable states to operate with impunity in their regional locales. It is also presumed that ICBMs are the only delivery mechanisms that can deter the U.S.S.R..

Areas for Potential Surprise

The areas of potential surprise cited are based upon an unexpected change in leadership as well as technological advancements that could potentially increase the capability of weapons development. To wit: "There is the possibility that nuclear weapons get into the hands of almost totally irresponsible governments." "A technological breakthrough could markedly increase the capabilities of the countries discussed in this paper."

Risk of War

The 1957 NIE's overall judgment was that the spread of nuclear weapons to fourth countries would not in and of itself cause an increase in the likelihood of general warfare. In the 1958 NIE, it was judged that the spread of nuclear weapons would certainly cause issues and likely increase the chance of war through the expansion of local conflicts. To reflect the disagreement on this issue, the Deputy Director of Intelligence and the Joint Staff added a footnote noting the disagreement with the statement that "fourth country nuclear capabilities would probably tend to increase the chances of general war."

Other Major Conclusions and Unique Dimensions

The assessment concludes *inter alia* that:

- A large number of countries will have the capability to produce a few nominal-yield weapons and deliver them with aircraft by 1968;

- If reached, a U.S.-U.S.S.R. test-ban agreement would pressure other states to comply with this standard and thus impede proliferation;
- By 1963, only Sweden and West Germany would have the resources to independently produce nuclear weapons;
- The long-range goals of fourth countries are to produce thermonuclear weapons with a megaton yield and solid or liquid propellants; and
- 100 IRBMs with a 1500 mile range could be produced for $2 billion. A surface-to-surface missile program would cost $1 billion and could be produced by Western Europe and Japan because of their educational standards and competent scientists.

Assessment

Which aspects of the study stood the test of time (i.e. came true)? Which aspects have not?

China

The NIE assessed that China would not be pressured to forgo acquiring nuclear weapons by a disarmament agreement. The NIE 100-57 also argued that China would develop nuclear weapons with the assistance of the Soviet Union. "Communist China could, with Soviet assistance, produce fission weapons on its own territory." It also pointed out that China was likely to continue depending on the Soviet Union for its military advancement in the years to come. "Peiping would probably continue to recognize its fundamental dependence on the U.S.S.R. for strategic security."

Comment: The authors were correct in their assessment that China was actively seeking to develop nuclear weapons. However, China obtained nuclear weapons without Soviet assistance and the Sino-Soviet split occurred in 1960, two years after the NIE report was released. The NIE concluded that it was unlikely that China could produce missiles with the capacity of carrying nuclear warheads by 1968. This underestimated China's capabilities. In 1966, China launched its first guided missile capable of carrying a nuclear warhead.

Sweden

Sweden has the independent capability to produce a substantial stockpile of nuclear weapons by 1968. The assessment predicts that by 1961 Sweden will initiate a nuclear weapons production program. Its authors also estimated that if Sweden increases its amount of fuel it could produce 75 kg of PU by 1961, 200 kg by 1963, and 400 kg by 1968. In 1963, Sweden would have the capability to start producing nuclear weapons. Sweden also has a developed delivery system, which contains two types of fighter-bombers. By 1966-68 Sweden can obtain an adequate nuclear delivery missile system. "Sweden will initiate production of nuclear weapons," if the U.S.S.R. does not disarm. Sweden is considered to seek nuclear weapons for the "buttressing of a neutral position."

Comment: In the mid-1960s, the Swedish government decided not to acquire nuclear weapons, though some nuclear weapons-related activities continued for some time after the announcement. One of the constraints on Sweden's early program was the difficulty related to acquiring fissile material from an otherwise civilian nuclear research program. Instead, Sweden moved to the forefront of the international nuclear disarmament movement.

Canada

The NIE predicted that Canada would have an independent capability to produce a growing stockpile of plutonium – 100 kg of Pu by 1963 and 350 kg by 1968. It is also estimated that Canada could produce a small stockpile of nuclear weapons by 1968 without access to foreign assistance. The NIE noted, however, that while Canada has the capacity to produce a nuclear device, it had made an agreement to sell all of its plutonium to the United States. Canada possesses a modern aircraft system with the potential of being used for bombers. However, the NIE judged that in order to deter the U.S.S.R., Canada would need ICBMs. According to the study, the production of ICBMs could be achieved in ten years but it would require an enormous effort unless Canada sought foreign assistance. The NIE concluded that Canada would not seek to produce nuclear weapons but rather it would rely on the U.S. extended deterrence policy.

Comment: By the late 1940s, Canada had decided not to acquire nuclear weapons. This study's emphasis on technical capabilities led the authors to give more credence to the possibility of a Canadian bomb than otherwise would have been warranted.

France

France was expected to continue its nuclear weapons program to reestablish itself as a power, to gain prestige, and for military effectiveness in local conflicts. The NIE concluded that France would have the capability to produce indigenously a substantial stockpile of nuclear weapons by 1968. A possible U.S.-Soviet test ban would not impose sufficient pressures to keep France from that nuclear goal. More specifically, the analysts predicted that France would test a fission weapon of 20-40kt yield by 1958 or early 1959. The study also estimated that France could produce a limited nuclear missile capability by 1963-64 and an operational capability by 1966-67. It could arm long-range missiles with thermonuclear warheads by 1968 as well as produce a "family of fission weapons." The authors judged, however, that France would be unable to support an extensive nuclear program without strains on its resources, thereby providing an incentive to pursue regional cooperation and production.

Comment: France tested its first fission weapon in 1960 and achieved a thermonuclear weapon capability by 1968. Its nuclear weapons program did strain its conventional military capabilities but France remained dedicated to its independent nuclear force.

West Germany

The NIE expected that if France acquired nuclear weapons, West Germany would seek access to nuclear weapons, either via an independent nuclear weapons program or other means. Specifically, a French program would "generate pressure in Germany for the removal of the WEU Treaty restrictions on German weapons production . . . ." However, the NIE also judged that Germany could be prepared to accept the alternative of U.S. dual-key nuclear programs of cooperation.

Comment: Considerable efforts had to be made within the NATO alliance to assuage German nuclear security concerns. Dual-key weapons proved only a partial solution, with the discussion (not implemented) of a Multi-lateral Force and ultimately the creation of the NATO Nuclear Planning Group.

The FIG, SIX, and UK

The NIE examined the possibility of combined efforts to produce nuclear weapons by what it termed the FIG (France, Italy, and West Germany). It assessed that the FIG efforts would assist the countries involved by spreading the costs of building a nuclear weapons program. In particular, the FIG states could collaboratively develop facilities capable of processing weapons-grade fissile materials. The analysts ultimately judged that any such FIG alliance would be limited to the production of missile capabilities. The SIX countries – the WEU countries – were thought likely to pursue nuclear weapons if the FIG were to proceed with a program. The performers concluded that this grouping could produce fission weapons by 1968 if it obtained needed uranium from the Belgian Congo. The UK was seen as strongly opposed to the FIG's production of nuclear weapons but in favor of a nuclear program under WEU and NATO. The UK, however, would not support such a program without U.S. backing.

Comment: The combination of NATO dual-key systems as well as the eventual Nuclear Planning Group served to neutralize nuclear incentives of most WEU countries. The eventual Treaty on the Nonproliferation of Nuclear Weapons also made nuclear collaboration considerably more difficult.

Eastern European Countries

The performers accurately predicted that the U.S.S.R. would block East Germany or Czechoslovakia from starting a nuclear weapons program.

Japan

The estimate judged that Japan was unlikely to begin a nuclear weapons program in the time period being analyzed, assuming that international controls remained in effect. It was predicted that Japan could produce missiles that could target China and the Soviet Union but would not be able technically to produce fission weapons until the 1970s. It was assumed that in the absence of nonproliferation commitments, Japan would eventually seek a nuclear

missile system to serve as a deterrent. However, according to this estimate, a nuclear Japan would not necessarily affect U.S. interests.

Comment: While correct in its assumption that Japan would be unlikely to develop nuclear weapons, the NIE may have underestimated the importance of domestic factors in that policy.

Italy
The NIE predicted that Italy could and is likely to produce nuclear weapons that could target the U.S.S.R. between 1968 and 1970.

Comment: This judgment proved wrong, in part due to the NATO Alliance's nuclear role. The NIE may also have overestimated the appeal of nuclear weapons to Italy and the impact France's nuclear weapons program had on the country.

Israel
Israel is likely to pursue a nuclear weapons program by 1968.

Comment: In 1966, Israel completed the research stage of its nuclear program with the capability of producing 14-40 kg of Pu per year. It is reported that Israel assembled its first nuclear weapon on the eve of the 1967 Six-Day War.

India
The NIE assessed that although India would possess the resources necessary to produce nuclear weapons by 1968, it would be unlikely to do so.

Comment: This judgment over-estimated India's technical advances. It also could not anticipate the impact on India's perception of China's 1964 nuclear test.

Did the particular methodology used influence what the study "got right" and what it "got wrong"? How replicable is the methodology? Can it be employed by others?
Country case studies have become the core methodology of proliferation forecasting. Some of the NIE's assumptions, however, may have impacted the accuracy of its forecast, for example, the assumption that China would need Soviet assistance. The NIE's emphasis on spillover effects may also have overestimated the impact of France's acquisition of nuclear weapons on its neighbors. These limitations suggest the importance of finding ways to test mindsets and assumptions when using any such forecasting methodology.

Was the study influential in some way? If so, how and why? What factors led decision-makers to take notice of it?
In October, following the distribution of the NIE report, the Department of State sought to investigate the status of the French Nuclear program, the FIG, and the WEU projects. The Department also called for a more in-depth and accurate analysis of the countries' ballistic-

missile efforts. Most important, the United States moved ahead with actions to enhance NATO's nuclear role and the dual-key component of the U.S. nuclear security guarantee to European allies.

Was the study itself influential in changing the course of events, (i.e., did policy intervention result in some aspects of the study being proven wrong)? Or did other external factors change the outcome?

The study's emphasis on the dangers of proliferation likely contributed to U.S. efforts to enhance the nuclear security guarantee to European allies. This guarantee continued to evolve and proved essential in checking proliferation pressures in Europe. More broadly, the warnings of proliferation in the 1958 NIE, like those of the 1957 NIE, contributed to greater policy interest in the problem.

Likelihood and Consequences of Proliferation of Nuclear Weapons Systems

In National Intelligence Estimate. Washington, D.C.
National Intelligence Council, 1963

Overview

This forecast primarily entailed a series of country case studies. In carrying out these case studies, it focused on the nexus between technical capabilities and motivational factors in making judgments about proliferation propensity. This provided a more nuanced and qualified set of assessments than earlier assessments (which had a more one-dimensional technology-push emphasis). The forecast's assessment of the time needed by given countries to produce a nuclear weapon may well have been underestimated. In part, this underestimation reflected the difficulties of factoring "wild cards" (e.g., deaths of key individuals) into an estimate potential. The forecast may have overestimated the future spread of nuclear energy as well as the pursuit of a civilian nuclear energy program – vice a dedicated program – as a route to the bomb. A focus on the most obvious route that a country might follow to obtain a nuclear weapons capability proved misleading – as exemplified by the NIE's emphasis on China's building of a plutonium production reactor. The importance of internal political considerations was rightly noted.

Author

It was prepared by the CIA with participation from the CIA and Departments of State, Defense, the Army, the Navy, the Air Force, Atomic Energy Commission, and NSA.

Purpose and Objectives

To estimate the capabilities and intentions of additional countries to develop and produce nuclear weapons and compatible delivery systems in the next 10 years as well as to estimate the subsequent consequences of those developments.

Timeframe Examined

1963 through 1973 (ten years)

Prevailing Context

Within the Kennedy Administration there was increasing concern about the possible proliferation of nuclear weapons. In part, this concern reflected the recent emergence of France as a nuclear weapon state and China's pursuit of nuclear weapons. In part, concern about proliferation reflected an increased interest in nuclear energy on the part of a growing number of countries. This concern about proliferation was expressed in President Kennedy's June 1963 American University speech in which he warned of the spread of nuclear weapons. This NIE was also conducted at a time when the Kennedy Administration was assessing different options for nuclear testing limitations. It shortly preceded the negotiation of the Limited Test Ban Treaty.

Methodology: Country Case Studies – Technology-Motivations Interactions
This assessment entailed a series of country studies. For each study, the NIE focused on a set of critical variables, including time lag, technical capability, existence of a nuclear energy program, and motivations to forecast a country's proliferation propensity. In applying these variables, the assessment first considered the technical capabilities (nuclear and missile) of the program, then factored in motivational aspects (internal issues and implications of other countries' proliferation successes). This nexus between the technical and motivational factors was seen as essential to make a judgment about "if" – a country's future propensity to proliferate or not. The assessment then forecasts the specific country's proliferation propensity over the coming decade, often using various qualifying statements, for example: " if [ ]... were to happen, then ... [ ] could make a decision to," "evidence with respect to … is insufficient to make a confident conclusion"; and "could probably"…and "fairly advanced."

With regard to specific sections, the assessment covers:

I. General Considerations Bearing on Nuclear Proliferation
II. Capabilities and Intentions of Potential Nuclear Candidates (technical and internal motivational factors to proliferate)
III. Implications of the Success of Specific Programs (factors of external proliferation)
IV. Broad Implications of Nuclear Proliferation

Key Projections/Forecasts
The assessment included an evaluation of how rapidly a series of countries with both the physical and financial resources could acquire nuclear weapons in the 1963-1973 timeframe. The countries were:

Canada	First device in 1-2 years after decision
Israel	First device in 2-3 years after decision
Sweden	First device in 2-3 years after decision
West Germany	First device in 4-5 years after decision
India	First device in 4-5 years after decision
Japan	First device in 2-3 years after decision
Communist China	First device in 2-3 years after decision

Specific Country Forecasts of Proliferation Propensity:

Canada
Although Canada could easily develop nuclear weapons, its political parties and constituents were judged to oppose acquisition of nuclear weapons.

Comment: This judgment stood the test of time.

China

China's small air-cooled reactor was judged to be incapable of producing enough plutonium for more than two low-yield fission weapons per year. "If the reactor went critical in early 1962 – the earliest date – and the Chinese experienced no major problems in chemical separation or metal fabrication, the earliest a first device could be tested using plutonium from this reactor alone would be early 1964. However, if the reactor were not to go critical in 1962 or if the Chinese encountered the normal run of difficulties, the more likely date for a first device would be late 1964 or beyond." The drafters judged that approximately two years after a first nuclear test, the Chinese could probably produce their first crude, operational fission weapon. They predicted that China would be incapable of acquiring more than a relatively small operational capability in the present decade.

Comment: This judgment proved faulty in two important respects. China's first nuclear weapon was based not on plutonium but on highly-enriched uranium, a possibility that this NIE failed to emphasize. Second, within two years of China's first nuclear test, China went on to test a thermonuclear weapon. In both instances, the initial judgment significantly underestimated China's technical capabilities. This failure to focus on China's enrichment program was an initial example of a persistent trend in U.S. proliferation projections of focusing only on the most prominent route to the bomb for a given country, rather than all potential routes.

The assessment judged accurately that if the Chinese were successful at developing their first nuclear weapons in mid-1960s, they would be able to rely on TU-4 and TU-16 aircraft to deliver them. However, the assessment underestimated China's ability to produce ballistic missiles by arguing that the Chinese would not develop medium-range missile systems until the late 1960s. In fact, China developed its first ballistic missile in 1966. However, China does not appear to have been able to miniaturize nuclear devices for missile delivery until later, closer to the 1980s.

The authors also stated that "We do not believe that the explosion of a first device, or even the acquisition of a limited nuclear weapons capability, would produce major changes in Communist China's foreign policy in the sense that the Chinese would adopt a general policy of open military aggression, or even become willing to take significantly greater military risks."

Comment: This judgment proved accurate.

France

The NIE assessed that if France continued to encounter technical difficulties in the construction of its gaseous diffusion plant, it could seek German technical assistance. This judgment reflected wider concerns about German acquisition of nuclear weapons, linked partly to the French program. According to the drafters, "While many Europeans are in general sympathy with de Gaulle's challenge to U.S. dominance of the alliance, they are also

fearful that the existence of an independent French nuclear force will increase the likelihood of further nuclear proliferation, further erode the NATO concept, and perhaps most important, provide the vehicle for German acquisition of nuclear weapons."

Comment: Under President de Gaulle, France vigorously pursued its own nuclear independence and indigenous program. Fears of German pursuit of nuclear weapons proved a self-denying prophecy: U.S.-led NATO actions (e.g., creation of NATO's Nuclear Planning Group) combined with internal German political interests neutralized any interest in nuclear acquisition.

India

According to the drafters, "China's success[ful] nuclear test will further motivate the Indians to consider developing nuclear weapons, but that the explosion alone will not push the Indians to develop a weapon."

Comment: This judgment is ambiguous. China's possession of nuclear weapons was an important motivator of India's pursuit of nuclear weapons. But even with that Chinese push, the Indian program evolved very slowly over the ensuing decades.

The forecast went on to assess that: "India could reach a position of independence from present controls in about two years, after which time it would take another two or three years for India to produce its first nuclear device. By about 1970, India could have a limited nuclear capability using aircraft."

Comment: This technical forecast underestimated how long it would take India to acquire a nuclear weapon capability. India tested its first "peaceful nuclear explosion" in 1974 and there is no evidence in the open sources that confirms that they would have been able to deliver it against an enemy at that time. The NIE may have underestimated the timing of a nuclear India partly because the head of India's atomic energy program died in an airplane crash a year after the NIE was concluded. Moreover, the death of then-Prime Minister Nehru and the fact that his immediate successor Lal Badri Shastri was relatively politically weak likely slowed the program's advance. Both of these factors were unexpected "wild cards."

Israel

The assessment projected that the Israelis would acquire a nuclear capability to intimidate the Arabs, not to use in war. The Arabs will blame the West for allowing Israel to become nuclear, the assessment continued, while the Soviets will find ways of exploiting it.

Comment: The assessment proved correct that Israel would not view nuclear weapons as war-fighting means. However, Israel also did not use its possession of nuclear weapons to openly intimidate its Arab neighbors but instead pursued a posture of what has been termed "nuclear opacity."

Italy
Without a radical change in national sentiment, the NIE projected that it is unlikely that Italy would do more than continue in its present nonmilitary nuclear energy program. The swing to the left of the Italian electorate during the 1963 national elections was seen to reinforce this decision for some time.

Comment: As forecasted, Italy did not seek nuclear weapons for various reasons, including its alliances with the U.S. and NATO as well as internal developments.

Japan
The NIE assessed that if Japan made the decision to go ahead within the next year or so (of 1963), it could probably develop an operational nuclear capability using aircraft by 1970. The deep-rooted reluctance of the Japanese to undertake a nuclear weapons program, however, was seen to make it unlikely that Japan would initiate such a program within the next decade.

Comment: This forecast was accurate, although it may have underestimated Japan's pursuit of what has come to be called a "latent" nuclear capability.

Sweden
If a decision to go ahead is made in the next year or two, the Swedes could test a first device two or three years later. Moreover, if the Swedes decided to press ahead after the first detonation, they could have a weapon deliverable by aircraft by about 1968 and a missile system carrying compatible fission warheads by 1970. "If the trend toward nuclear proliferation continues and it appears unlikely that progress is being made toward a test ban or broader disarmament arrangements, the Swedish Government will be under increasing internal pressure to resolve the nuclear weapons question."

Comment: By this time, the sentiment in Sweden was already turning against the decision to pursue nuclear weapons. This assessment, however, may have overestimated the internal pressures on Sweden to seek nuclear weapons. Indeed, by the early 1960s, the domestic politics in Sweden were shifting toward anti-nuclear political parties. Additionally, the assessment does not take into account the later-disclosed importance of Sweden's perceived de facto coverage by the U.S. nuclear guarantee in Europe. This may reflect too much emphasis on the spillover effects of initial proliferation regardless of more unique country factors.

West Germany
According to the drafters, there were no indications of any plans by West Germany for developing an independent nuclear weapons capability. However, the assessment stated that, "Our information is insufficient to make a confident judgment as to future developments. We believe that West Germany is probably seeking through its broadly based nuclear program to increase its industrial and technical competence in fields related to nuclear

technology and eventually to become a world leader in the nuclear sciences. As a possible consequence…West Germany may become a major world supplier of nuclear technicians and components."

Comment: Although West Germany did not develop nuclear weapons, it did develop a strong nuclear industry and is a major player in the uranium enrichment market, just as the drafters of this estimate forecasted.

Outlier Nations

The authors add that it could not be ruled out that at some point within the next decade, a country with a growing sense of national ambition such as Indonesia could decide to enter into the "nuclear weapons field."

Comment: No outlier country developed a nuclear weapons program during the 1963-1973 time frame of the estimate.

Nonproliferation Agreements

In an era in which the Kennedy administration was pondering the pursuit of what came to be the Nonproliferation Treaty, the NIE assessed that if the United States, the United Kingdom, and the Soviet Union could come together in terms of a "non-diffusion" agreement, that agreement would help prevent the acquisition of nuclear weapons by any non-nuclear signatories. Communist China would almost certainly refuse to sign. The French would certainly not sign unless they were considered one of the nuclear powers; even if France were accorded nuclear power status, the NIE assessed that French adherence would be doubtful. Nevertheless, the existence of such an agreement would constitute a political and psychological inhibition to the initiation of an independent weapons capability by other non-signatories and would reinforce internal opposition where it already existed.

Comment: For more than twenty years after the Nonproliferation Treaty (NPT) entry-into-force, both China and France refused to adhere to it. Additionally, although some hold out countries did develop nuclear weapons, the NPT did have a proliferation damping effect.

Other Significant Points:

Overall, proliferation was not seen as significantly changing the future global geopolitical-military environment as a whole. "In strictly military terms, the nuclear proliferation likely to occur over the next 10 years will almost certainly not upset global power relations. None of the prospective or potential nuclear powers will acquire capabilities, which, if added to those of the U.S. or U.S.S.R., would significantly affect East-West military relationships, or bulk large militarily as an independent force."

Comment: This proved accurate.

Regarding pursuit of nuclear energy, the NIE forecasted that, "an increasing number of nations will actively pursue nuclear energy programs right up to the threshold of a weapons capability. Such programs can be justified domestically as a source of energy and as providing a stimulus to the development of technological skills and sophisticated industries. Such a threshold capability would facilitate the development of a weapons program if circumstance required." Sweden and India were cited as examples.

Comment: While countries did pursue nuclear energy, this assessment may have overestimated the pace of that development as well as the role of nuclear energy programs as a pathway to nuclear weapons. Nuclear energy growth proved slower in the 1960s and 1970s than anticipated for technical and other reasons. Successful constraints in the 1970s on reprocessing and enrichment made it harder for countries to advance to the nuclear weapon threshold through nuclear power. In addition, while India did leverage its nuclear power program in moving to its 1974 test, some other countries pursued dedicated programs, such as Israel, Pakistan, and later North Korea. In Sweden's case, moreover, one contributing factor for its shift away from nuclear weapons was the recognition that it could not simply leverage its nuclear research and power program as a stepping-stone to the bomb.

Memorandum for the President: The Diffusion of Nuclear Weapons With and Without a Test Ban Agreement

Robert McNamara
Washington, D.C., 1963

Overview

Using an "alternative scenarios methodology," this memo assesses the impact of different types of nuclear testing limits on proliferation. In certain respects, its results reflect the context of the time. For example, its emphasis on the possibility of a Chinese bomb is quite consistent with China's advancing nuclear weapons program, which would result in a Chinese nuclear test in 1964. Similarly, its concern about the implications of widespread use of nuclear power fit with then-prevalent projections for nuclear power programs. Regarding proliferation forecasting, this memorandum's concern with the proliferation impact of nuclear power may show the extent to which particular forecasts are linked to the events of the time. Somewhat differently, it highlighted concerns that Sweden may reflect a "lag-time" phenomenon, in this case, in recognizing that a particular country had ceased to be a major source of proliferation concern.

Commissioned By

The President of the United States.

Purpose and Objectives

The purpose of this memorandum is to inform the President of the various policy options that are available to control the proliferation of nuclear weapons.

Timeframe Examined

1963 through 1973 (ten years)

Prevailing Context

This memorandum was written in the aftermath of the October 1962 Cuban Missile Crisis. Within the Kennedy Administration, there was an interest in the steps needed to strengthen the constraints on nuclear arms competition and proliferation; this interest led to the decision to send Ambassador Averill Harriman to Moscow in June 1963 to negotiate what became known as the Limited Nuclear Test Ban Treaty. This memorandum was also written at a time of concern about accelerating proliferation due to a number of factors, including the projected expansion of nuclear power. Possible Soviet assistance to China's nuclear weapons program also provided part of the background.

Methodology Used: Alternative Scenarios

This memorandum defines and assesses three different possible scenarios that could occur with regard to nuclear testing: 1) unrestricted nuclear testing, 2) a comprehensive ban on

nuclear testing, and 3) a partial nuclear test ban. The memorandum analyzes the expected impact of each scenario on the prospect of nuclear diffusion.

Key Projections/Forecasts

The assessment identified various incentives and disincentives for the acquisition of nuclear weapons. The incentives identified included the coercive and deterrent value of nuclear weapons as well as their prestige and military utility. The report identified as relevant disincentives: high costs, fear of international sanctions, legal restrictions, unclear military needs, moral pressures, and lack of assistance for programs in Soviet "satellite" countries.

The memorandum cited China as the country of greatest concern, with Israel, Sweden and India likely following. According to the memorandum, Chinese developments may motivate Australia and Japan to try to obtain nuclear weapons. West Germany and Italy might be pressured to start a nuclear program, and South Africa should not be ruled out.

Acquisition Patterns/Trends

The memorandum assesses the potential impact of expanding nuclear power use on proliferation, with nuclear power programs seen as shortcuts to military use. Use of nuclear power was seen as leading to potential access to plutonium, training of scientists and a general diffusion of technology. Specifically, the memorandum identifies eight countries, in addition to the existing four nuclear powers, that will have civilian nuclear capabilities by 1973. However, it was thought unlikely that all of the countries capable of pursuing nuclear weapons programs would start them. The memorandum estimated that depending on the country, it would take 1 – 10 years to complete a nuclear weapons program once the decision was made to start the program.

The memorandum estimated that starting a nuclear weapons program would cost approximately $150 – $175 million dollars. It predicted that the costs of acquiring nuclear weapons would decrease over time, linked to a decrease in the costs of producing fissile materials by a factor of 2-5.

The memorandum judged that a comprehensive ban on nuclear weapons testing was likely to slow proliferation. Moreover, the memorandum argued that a comprehensive test ban would facilitate much needed cooperation between the U.S. and the Soviet Union, a consideration that may have contributed to negotiations soon after the Limited Test Ban Treaty. However, the memorandum assessed that China would not likely agree to a comprehensive treaty. It would also be hard to persuade Israel and France to accept a comprehensive ban; at the time, France and China were not even prepared to sign the Partial Test Ban Treaty of 1963.

As for unrestricted testing, the memorandum concludes that while such testing might not have a substantial influence in the short-term, it is likely that it will increase proliferation over the long-term.

Finally, the likelihood that some countries could produce nuclear weapons without testing was addressed as a possibility. In addition, existing and proposed monitoring systems – either international or national – were considered to be incapable of detecting underground tests.

Assessment

Did the particular methodology used influence what the study "got right" and what it "got wrong"? How replicable is the methodology? Can it be employed by others?
An alternative scenarios methodology remains a proven means to examine future proliferation trends and assess how those trends might change under different conditions. In this case, the assessment considered how changes in the dependent variable – test ban policy – could impact proliferation trends. Later assessments considered how a mix of conditions could affect alternative scenarios for the independent variable – alternative scenarios for proliferation trends.

Was the study influential in some way? If so, how and why? What factors led decision-makers to take notice of it?
This memorandum raised awareness about the importance of U.S. test ban policy. Although its proposal was not accepted for the U.S. pursuit of a comprehensive test ban, its emphasis on the political payoffs of a test ban agreement with the Soviet Union may have contributed to the successful pursuit of the LTBT several months later.

Was the study itself influential in changing the course of events, (i.e., did policy intervention result in some aspects of the study being proven wrong)? Or did other external factors change the outcome?
This memorandum provided part of the background for the Kennedy Administration's decision to negotiate the Limited Test Ban Treaty, which was signed on October 10, 1963. This treaty banned nuclear weapons testing in the atmosphere, outer space, and under water.

A Report to the President by the Committee on Nuclear Proliferation

Edited by Gilpatric Committee, Washington, D.C
The White House, 1965

Overview

Directly linked to China's 1964 nuclear test and prepared by a group of "wise men," the Gilpatric Report uses an expert judgment Delphi methodology to warn that the world is on the brink of worldwide proliferation. That expert judgment is based on a number of critical international or external variables, e.g., regional insecurity and the pursuit of prestige. Increased national access to fissile material is seen to be the result of a trend toward growing global use of nuclear energy. On the other hand, internal variables received little attention, e.g., more unique country-specific political-psychological-cultural factors shaping national approaches to nuclear issues. In light of that forecast, the Report sets out a series of recommendations to prevent worldwide proliferation. The Report contributed to the Johnson Administration's pursuit of a nonproliferation treaty as well as the strengthening of U.S. nuclear security arrangements with key allies, Japan and Germany. Some other Report recommendations were not pursued, e.g., new security guarantees to Israel and India as well as other steps to provide alternatives to nuclear weapons for prestige.

Authors

This report was prepared by a group of senior "bipartisan wise men", chaired by then Deputy Secretary of Defense Roswell Gilpatric. The group was comprised of Arthur Dean (Senior Diplomat), James Perkins (President of Cornell University), Allen Dulles (Former Director of Central Intelligence), Arthur Watson (CEO of IBM), Alfred Gruenther (General – retired), William Webster, George Kistiakowsky (Harvard Professor), Herbert York (Director of Lawrence Livermore National Laboratory), and John McCloy (Senior Outsider).

Commissioned By

President Lyndon B. Johnson

Purpose and Objectives

The stated purpose was to study the problem of preventing the spread of nuclear weapons and put forward recommendations for how to deal with the problem. Unlike many of the other "studies" examined, its primary focus is not a forecast of future proliferation but rather a set of recommended policy actions.

Timeframe Examined

None explicitly stated. Implicitly, the next 1-5 years.

Prevailing Context

China tested a nuclear device in October 1964, which provided the immediate catalyst for this report. Additionally, there was growing concern about the possible contribution of more widespread uses of nuclear energy to the future proliferation of nuclear weapons. There was also uneasiness about the possible pursuit of nuclear weapons by other European countries, including Germany, which led to the consideration of possible multilateral nuclear arrangements for NATO. At the same time, negotiations were underway on what would become the Treaty on the Nonproliferation of Nuclear Weapons (NPT).

Methodology: Expert Judgment Delphi Method

The report relied on expert judgment by a group of "wise men". Their assessment focused heavily on several proliferation drivers: the impact of China's nuclear test as a triggering event, projected growth in the use of nuclear energy (giving more countries access to fissile material), regional and international security concerns, and the pursuit of international prestige. The group of wise men consulted with principal officers and relevant agencies in the U.S. Government to help make their own judgments about potential proliferation drivers and trends, consequences for the United States, and possible future policies. There was diversity within the group concerning the costs and feasibility of the policy proposals, which was clearly expressed in the Report.

Key Projections/Forecasts

Brink of Worldwide Proliferation

The report judged that the United States and other countries were on the brink of worldwide proliferation. Several factors were seen as potentially leading to such proliferation. These drivers of future proliferation were:

- China's acquisition of nuclear weapons, which was seen as compelling Japan and India to seek nuclear weapons programs, affecting in turn still other countries;
- The presence in other countries of fissile material, which was seen to be destabilizing regardless of its quality or grade;
- Pursuit of nuclear weapons as a source of international prestige;
- Heightened perceptions of security threats in countries' immediate regions; and
- Unconstrained technology transfers and exports from existing nuclear weapon powers.

Other Major Conclusions and Unique Dimensions

The Gilpatric Report set out a wide range of recommended actions aimed at preventing worldwide proliferation. These recommendations dealt with both global/regional initiatives and more country specific actions. The recommendations were as follows:

Global-Regional Recommendations:

The Report stated that the United States should intensify its efforts to negotiate and seek an early conclusion to a nonproliferation agreement. Strong pressure should be put on countries such as Germany, France, India, Japan, Israel, the United Arab Republic, and

Sweden to participate in such an agreement. Efforts should also be made to persuade the Soviet Union and its allies to support the treaty.

The United States should renew its efforts to negotiate and conclude a comprehensive nuclear test ban treaty. This step was seen as impeding national development programs.

The United States should pressure nation-states to maintain non-nuclear status. If states pursue the acquisition or manufacturing of nuclear weapons, the United States should impose economic sanctions.

The United States should support the establishment of nuclear free zones in Latin American and Africa (to include Israel and the United Arab Republic).

The United States should expand the influence and budget of the IAEA in order to ensure international safeguards on nuclear power reactors. EURATOM should use IAEA safeguards to ensure compliance with nonproliferation.

The United States should be prepared to reduce its own nuclear arsenal and overall reliance on strategic and tactical nuclear armaments through adherence to arms reduction treaties. Closely related, the Report contended that the United States should encourage other states such as the Soviet Union, Sweden, the United Kingdom, France, and Germany to accept future treaty limitations. China, on the other hand, was thought to be inevitably committed to expanding its nuclear capacity and have no interest in any such limiting agreements. Even so, the United States could seek to encourage China to apply IAEA safeguards to its nuclear energy program.

The use of Permissive Active Links (PALs) on United States nuclear weapons in Europe should be expanded to all United States nuclear weapons deployed overseas.

Recommendations for Specific Countries

India

The United States should encourage India to remain non-nuclear by providing a nuclear security umbrella and conditioning it on India remaining non-nuclear. The United States should also support India playing a larger role in the United Nations if it remains non-nuclear.

Japan

The United States must provide alternative prestige mechanisms to dissuade Japan from seeking nuclear weapons.

Israel
The United States should join a strategic alliance with Israel against the United Arab Republic, conditioned on Israel remaining non-nuclear.

United Arab Republic
The United States should motivate the United Arab Republic to reverse its nuclear program by dissuading France and Germany from the supplying necessary technology.

Germany
Whether or not to pursue a Multilateral Nuclear Force that includes Germany is considered but not resolved. The alternative discussed would entail a bilateral U.S.-German sharing agreement that is designed to avoid an independent German nuclear program.

France
The United States should continue to oppose France's independent nuclear weapons program, including nuclear testing by France.

Soviet Union
The United States should promote the limiting of fissile materials and delivery vehicles. There should also be a delay in the development of ballistic missile defense as well as pursuit of an agreement with the Soviet Union to halt the production of ICBMs.

Assessment

Which aspects of the study stood the test of time (i.e. came true)? Which aspects have not?
The report concluded that China's nuclear weapons development was inevitable.

Comment: China did continue to develop its nuclear weapons program.

The report predicted that Israel could be kept from pursuing nuclear weapons by a combination of pressure from the United States and the provision of a U.S. nuclear umbrella.

Comment: U.S. pressure alone proved insufficient to dissuade Israel from acquiring nuclear weapons and ultimately the pressure was relaxed.

The report projected that Japan might be influenced to seek nuclear weapons if its neighbor China does so.

Comment: Concerns about China's nuclear status did create insecurity in Japan but ties to the United States provided an alternative security mechanism. In addition, domestic political factors, the post-war nuclear allergy, also played an important part in Japan's calculations.

Did the particular methodology used influence what the study "got right" and what it "got wrong"? How replicable is the methodology? Can it be employed by others?
The "wise men" group focused primarily on external influences and the international political environment. They placed less emphasis on the role of key leaders, national strategic personalities, and domestic political considerations. These latter factors, however, played a part both in Israel's pursuit of nuclear weapons and Japan's decision not to do so.

The Delphic Survey by a group of wise men is a methodology that can be readily replicated – and has often been – in thinking about future proliferation trends and related policy issues. Its use of trends analysis and triggering events is also replicable.

Was the study influential in some way? If so, how and why? What factors led decision-makers to take notice of it?
Many, but not all of the Report's recommendations were later pursued. For instance, the study suggested that the United States propose an internationally binding treaty to stop the spread of nuclear weapons. It also suggested that the United States seek ways to reinforce the U.S. nuclear guarantee to Germany and Japan as a means to prevent proliferation. But the Report's recommendation that the United States extend deterrence outside of Europe was not pursued, e.g., with Israel and India. Nor did was its recommendation of a significant reduction in the nuclear stockpiles pursued.

Was the study itself influential in changing the course of events, (i.e., did policy intervention result in some aspects of the study being proven wrong)? Or did other external factors change the outcome?
The Gilpatric Report was a significant step towards a nonproliferation regime. The Report influenced President Johnson's nonproliferation policy, including the strengthening of the nuclear linkage to Germany as well as the pursuit of what came to be known as the NPT. Some of its recommendations did set in motion developments that helped to prevent its worst fears of worldwide proliferation.

Nuclear Proliferation Phase II

Robert M. Lawrence and Joel Larus, eds
National Security Education Program: University Press of Kansas, 1974

Overview
Written shortly after the entry-into-force of the Treaty on the Nonproliferation of Nuclear Weapons (NPT), this book is composed of overview essays and a set of country case studies. Even though the case studies provided insights into national security thinking in these countries, they underestimated the role of domestic factors. The case studies also did not pay sufficient attention to the impact of wild cards and unexpected regional developments in shaping proliferation choices in directions thought to be unlikely by the authors.

Commissioned By
National Security Education Program of New York University

Purpose and Objectives
The editors of the book state that their objective was to examine why some states chose to accept or reject the NPT.

Timeframe Examined
The book is mainly focused on the negotiation, signing, and entry-into-force of the NPT – from the early 1960s to the early 1970s. Some of the essays also look at the future of the nuclear nonproliferation regime.

Prevailing Context
The essays were written shortly after the NPT entered-into-force in 1970. The nuclear nonproliferation regime was strengthened by the treaty's fairly wide approval. However, the number of states that refused to sign it at that time was also troubling, especially since several seemed determined to possess nuclear weapons for a variety of reasons. Since China in 1964, no other country had openly acquired nuclear weapons. India's 1974 nuclear test of a so-called peaceful nuclear explosive had yet to occur. More broadly, the United States and the Soviet Union had signed the Strategic Arms Limitation Treaty (SALT I) and the Anti-Ballistic Missile Treaty (ABM), which created expectations of further arms control.

Methodology: Country-Case Studies – National Expert Analysis
The case study methodology includes reliance on assessments from nationals of the specific countries examined. The case studies emphasize security considerations – as reflected in official thinking and doctrines – as the primary proliferation driver. The book is a collection of eight essays: one essay is a background discussion on the Nuclear Nonproliferation Treaty (NPT), one essay is on nuclear weapons technology, and the six other essays are case studies that explore the decisions to accept or reject the NPT made by individual states. The individual state essays were written by authors originating from the nations in question.

Each case study assessed the likelihood that the state would decide to acquire nuclear weapons, while seeking to summarize official thinking on this question. Given their emphasis on official doctrine, these case studies put the most emphasis on security considerations as opposed to more technical or internal political-bureaucratic-cultural factors.

Key Projections/Forecasts

Prospects for Proliferation

In their conclusion, the two editors judged that additional countries would acquire nuclear weapons. No legal measures would hold the number of nuclear weapon states to the five states recognized in the NPT.

Comment: Very soon after the book was published, India tested its first nuclear explosive in 1974. Israel also likely possessed a small nuclear arsenal by this point. In turn, South Africa was building nuclear weapons by the end of the decade.

Country Specific Assessments:

Australia

The essay on Australia predicted that if the United States were to abrogate the Australia-New Zealand-United States Security Treaty (ANZUS Treaty), then Australia would likely try to build its own nuclear weapons. Its motivation would be to provide an alternative to its reliance on the United States for its security. However, the author noted that such an abrogation looked unlikely.

Comment: The United States did not leave the ANZUS Treaty. U.S.-Australian security relations remained one of the main reasons why Australia did not make serious, sustained attempts at building a nuclear weapons program. However, over time, domestic political considerations also played an important part in this decision.

West Germany

The essay reflecting on West Germany emphasized the unique dimensions of the cooperation between the United States and the Soviet Union in pushing for the NPT. The author surmised that West Germany political leadership did not expect that such cooperation would recur. This cooperation was seen as a driving force that pulled the rest of the world along into the NPT, including ultimately West Germany.

India

Various factors were highlighted that might lead the Indian Government to build nuclear weapons. They were:

- External threats from China or Pakistan that might require a military-nuclear response or the ability to negotiate from a nuclear position;
- A superpower presence in the Indian Ocean – especially a nuclear-armed presence;

- Increasingly close American relations with Asia and Pakistan left India feeling vulnerable; and
- The inherent unfairness of the NPT – separating the world into nuclear haves and have-nots.

Comment: Most of these factors have been cited over the years as the reasons for India's decision to build a nuclear stockpile. However, other domestic political and bureaucratic factors as well as leadership preferences were also important determinants of India's posture. These other factors were not highlighted due to the focus on more traditional security drivers.

Israel

The essay suggested that continued Soviet involvement in the Middle East, especially in Egypt, could lead Israel to declare its nuclear weapons capability.

Comment: Despite continued Soviet ties to various Middle Eastern states, Israel never officially declared its nuclear weapons capability. Israel's decision reflected a number of considerations, including the purpose of Israeli nuclear weapons was last resort, the regional and global political benefits to Israel of not openly declaring its nuclear status, and the leadership's reluctance to integrate nuclear weapons fully into Israel's day-to-day defense posture.

Japan

Three main issues were seen as possibly causing Japan to refuse to adhere to the NPT and seek nuclear weapons. These were:

- Continued external threats (e.g., from a nuclear China);
- Abandonment by the United States, forcing Japan to take care of its own security; and
- Pressure by the U.S. to ratify the NPT, resulting in a rise in Japanese nationalism.

Comment: After a vigorous internal debate, Japan signed and ratified the NPT. As indicated, the U.S. security guarantee was and has remained a key factor in shaping Japan's readiness to renounce nuclear weapons. While Japanese nationalism has increased in successive decades, it has never reached the point at which Japanese leaders considered giving up the U.S.'s security guarantees in favor of Japan's own nuclear arsenal.

South Africa

The case study suggests that it is unlikely that South Africa would build nuclear weapons. This forecast rested on three judgments, which included:

- South Africa would not likely build nuclear weapons if doing so meant damage to cooperative relationships with traditional allies;

- South Africa would not likely build nuclear weapons if doing so jeopardized its strategic advances in the world. In other words, if having nuclear arms might hurt its political and economic advancement; and
- South Africa appeared to have more to gain from using its nuclear resources to strengthen commercial and technological ties with other nations, rather than hoarding them to build its own nuclear arms.

Comment: All of these judgments were confounded by later developments. In particular, due to its apartheid regime, South Africa was internationally shunned, politically and economically, from both its traditional allies and the broader global community. With economic and political sanctions, the opportunity costs of going nuclear also increasingly declined. Soviet and Cuban presence in southern Africa from the mid-1970s onward also transformed South Africa's perceived security environment. As a result, South Africa started building nuclear weapons capability very shortly after the essay's forecasts. Quite likely, its leaders believed that they had nothing to lose by taking that course of action.

Assessment

Which aspects of the study stood the test of time (i.e. came true)? Which aspects have not?

As noted, the editors' major, if not necessarily very difficult, projection that there would be additional proliferation beyond the five NPT nuclear-weapon states was correct. The specific essays appear to have underestimated the likelihood, however, that India would move very slowly towards nuclear weapons after its 1974 test as well as that Israel would not deploy nuclear weapons openly. It rightly identified possible reasons for South Africa to remain non-nuclear but underestimated the extent to which those conditions were eroding or about to be upset by the wild card of Soviet-Cuban intervention in the soon-to-begin Angolan civil war.

Did the particular methodology used influence what the study "got right" and what it "got wrong"? How replicable is the methodology? Can it be employed by others?

Having nationals of specific countries write the case studies was intended to ensure that the authors were knowledgeable about their government's security policies. This methodology did lead to occasional insights about each of the countries in question; however, many of the nuclear drivers listed in each country were already well-known to U.S. analysts. Moreover, analysts from the nations did not turn out to be more accurate than outsiders might have been. Additionally, perhaps because of the heavy focus on security motivations, other important factors were not given sufficient weight. The close linkage to existing security policies as opposed to speculating about the future environment meant that important changes were not highlighted.

The methodology of case studies by experts from the countries in question is replicable though its comparative advantage compared to reliance on experts regardless of their country of origin is not clear. Indeed, depending on the particular country, nationals may have less knowledge of programs and policies or be less able to reveal them for fear of punitive action.

Was the study influential in some way? If so, how and why? What factors led decision-makers to take notice of it?

This study was part of an overall increase in analytic attention paid to the problem of nuclear proliferation during the 1970s.

Was the study itself influential in changing the course of events, (i.e., did policy intervention result in some aspects of the study being proven wrong)? Or did other external factors change the outcome?

Independent of the assessments, external political-economic changes and wild cards did fundamentally change the context in which several of the nations in question made decisions on the costs and benefits of seeking nuclear weapons.

Soviet Forces for Intercontinental Attack Through the Mid-1980s (Volume 1 of 3)

In National Intelligence Estimate, *Washington, D.C. National Intelligence Council, 1975*

Overview

This estimate focused on the present and future Soviet forces for intercontinental attack (using ICBMs, SLBMs, and bombers) and strategic defense against bombers, missiles, and ballistic missile submarines. It examines the prospect of intercontinental conflict with the U.S.S.R. by analyzing three main topics: Soviet offensive capabilities, defensive capabilities, and projected future Soviet capabilities. The latter projection is based on estimates of improvements in Soviet strategic missile and defensive technology as well as the outcome of the SALT II negotiations. Rather than a single estimate, the NIE offers a set of alternative projections. Per its mandate, the estimate focused heavily on the military aspects of conflict. The wild card, the 1979 Soviet invasion of Afghanistan, contributed to the refusal of the U.S. Senate to give its advice and consent to the ratification of what came to be the SALT II agreement. Thus, the NIE's projections of Soviet forces under different SALT II scenarios were largely overtaken by events.

The report was broken into three volumes. Volume I presents the key judgments and a summary of the estimate. Volume II is the full estimate and Volume III is a set of annexes that includes tables on future projections and supplementary technical material on ICBM accuracies and directed-energy weapon systems.

Authors

The contributors were the Central Intelligence Agency, intelligence organizations part of the Departments of State and Defense, and the Energy Research and Development Administration.

Commissioned By

The Director of Central Intelligence.

Purpose and Objectives

The purpose was to analyze the Soviet Union's capabilities in terms of strategic missile capabilities and defense.

Timeframe Examined

1975 through 1985.

Prevailing Context

Globally, the prevailing context was a period of relative détente in the ongoing Cold War confrontation. The 1972 Strategic Arms Limitation Agreement (SALT I) had been signed

and ratified by both sides to place limits on their strategic nuclear forces. They also had signed and ratified the Anti-Ballistic Missile (ABM) Treaty, limiting deployments of ballistic missile defenses. Negotiations were underway for a follow-on SALT II agreement. President Gerald Ford and General Secretary Leonid Brezhnev had reached the Vladivostok Agreement in November 1974, which was intended by the U.S. to remedy some of the perceived flaws of the SALT I agreement. Domestically, the SALT I agreement had been heavily criticized because it was viewed as providing the Soviet Union with strategic advantages. The Jackson Amendment that accompanied its passage called for the United States not to accept strategic forces inferior to those of the Soviet Union. A little over a year after the jump in oil prices during the 1973 Middle East War, the United States was experiencing the beginning of an economic crisis related to the supply of petroleum.

Methodology: Alternative Outcomes, Quantitative Modeling

Based on what was known about the Soviet Union's capabilities, the estimate evaluated Soviet capabilities for attack and survival during an intercontinental nuclear conflict. To do so, it developed a series of projections of future Soviet offensive and defensive capabilities, dependent on the possible outcomes of the SALT II negotiations as well as future Soviet research and development efforts. Little emphasis was given to overall economic capability, political will, and leadership.

Key Projections/Forecasts

The NIE judged that the United States maintained a qualitative superiority in ICBMs and SLBMs, while the Soviet Union had a quantitative advantage in terms of the strategic balance. The Soviet Union was seen to maintain the largest air defense system in the world and devoted more resources to improving and maintaining defensive capabilities than on improving capabilities for intercontinental attack. The future strategic balance would depend most heavily on the success or failure of the SALT II negotiations and technological advances on each side.

Overall, this estimate explored various projections for Soviet strategic forces. Each considered one outcome of the SALT II negotiations as well as the bilateral political situation and Soviet technical achievements. According to the author's findings, new systems deployment will continue at about the pace demonstrated at the time of this NIE's writing. ICBM accuracy will continue to improve as well as force survivability and flexibility.

Future Strategic Balance

The strategic balance between the United States and the Soviet Union was characterized by the nations' efforts to utilize and improve upon the technologies developed by the other. Improvements in offensive weapons have led to improvements in defensive measures in both countries.

The NIE highlighted that the Soviet Union maintains a quantitative advantage over the United States in strategic offensive nuclear forces. This advantage was likely to continue

into the future across the alternative scenarios identified. Specifically, the NIE estimated that the Soviet Union would continue its development and deployment of new ICBMs, resulting in a growing Soviet capacity to destroy hardened missile silos in the United States. Based on the Soviet developments of low-altitude detection systems, it would become more difficult for U.S. bombers to penetrate Soviet airspace.

Possible new technologies that could upset the strategic balance were assessed. The NIE focused heavily on laser technology for both countries. Other cutting edge technologies discussed included particle beams, non-acoustic submarine technologies, and improved radar systems.

Nonetheless, the overall NIE judgment was that it was unlikely that any one event would tip the U.S.-Soviet strategic balance decisively to the advantage of either side. In the event of a conflict, both states would likely rely first on conventional weapons because a nuclear attack would provoke massive retaliation. In particular, the NIE assessed that uncertainty about the precise offensive (and retaliatory) capabilities of the adversary would make massive first strikes unlikely. Neither state could guarantee absolute success.

Assessment

Which aspects of the study have withstood the test of time (i.e. came true)? Which aspects have not?

During the 1975-1985 period of the estimate, as projected, the strategic balance remained basically stable, if measured using the metric that neither side had incentive to launch a first strike. The NIE's judgment of a growing Soviet capacity to destroy U.S. silo-based missiles also proved accurate. The NIE's assumption that there would be a SALT II agreement proved wrong given the impact of the wild card of the Soviet invasion of Afghanistan as well growing U.S. political debate about Soviet pursuit of a nuclear advantage. Thus, this aspect of its projections was overtaken by events. In terms of technology, disruptive technologies, including lasers, influenced but did not develop at a sufficiently rapid pace to upset the strategic balance.

The NIE also accurately forecasted that the deployment of new systems and force survivability and flexibility would continue to improve. However, the author's were not certain about issues regarding the development of long-range cruise missiles or bombers given the lack of evidence that was available at the time.

Did the particular methodology used influence what the study "got right" and what it "got wrong"? How replicable is the methodology? Can it be employed by others?

An alternative scenarios methodology allowed the NIE to cover the range of future developments of the Soviet forces. Its assessment, however, was vulnerable to the collapse

of one of its critical assumptions that the SALT process would continue to produce a SALT II agreement.

The methodology, taking two variables and forming different scenarios based on their values, is replicable and widely used in many assessments.

Was the study influential in some way? If so, how and why? What factors led decision-makers to take notice of it?
With its overall reassuring assessment of the strategic balance, it is likely that this study facilitated the successful SALT II negotiations, even if other events resulted in the treaty not entering-into-force. At the same time, the NIE was not able to put an end to a highly political elite-public debate about Soviet strategic nuclear capabilities. Instead, there was considerable criticism of the strategic posture of the Carter Administration by outside former officials.

Was the study itself influential in changing the course of events, (i.e., did policy intervention result in some aspects of the study being proven wrong)? Or did other external factors change the outcome?
The actual course of events was not influenced directly by the estimate. However, the optimistic tone vis-à-vis arms limitation talks probably had some influence on their initial positive outcome. Similarly, the very high estimates of Soviet capabilities probably served to communicate to policymakers the urgency of the situation and need for a long-term remedy. However, external events, such as the invasion of Afghanistan, the U.S. economic crisis and change of leadership, the Soviet decision to deploy SS-20 missiles in Eastern Europe, and the change of Soviet leadership with the death of Brezhnev in 1982 also played a large role in the evolution of the U.S.-Soviet strategic relationship in the 1975-1985 period.

Trends in Nuclear Proliferation, 1975-1995: Projections, Problems and Policy Options

Lewis A. Dunn and Herman Kahn
Edited by Hudson Institute: U.S. Arms Control and Disarmament Agency, 1976

Overview

This study used an alternative futures methodology to develop a series of projections of possible proliferation trends from 1975-1995. These projections broke away from traditional country case studies and were made up of one or more inter-related proliferation chains of country decisions. In turn, the projections were intended to highlight the breadth of possible proliferation outcomes as well as the dynamics of proliferation,; not to forecast any single proliferation future. In developing these projections, the authors identified pressures for and the constraints upon a decision to acquire nuclear weapons by different states as well as the impact of proliferation triggering events and momentum. The projections were varied to show how changing conditions could result in differing outcomes in terms of the scope and pace of proliferation. Implications for policy were discussed. Over time, considerably less proliferation occurred than was forecast in the more extensive projections. In part, this "real world" outcome suggests that the alternative futures methodology may exaggerate proliferation possibilities even though it proves to be a valuable means for understanding the dynamics of the proliferation process. As with other forecasts summarized in this overall "forecasting project," unexpected developments and wild cards shaped the proliferation outcomes in ways not envisaged by this study; notwithstanding the fact that it did emphasize the importance of such events but as proliferation accelerators not proliferation decelerators.

Commissioned By

The U.S. Arms Control and Disarmament Agency.

Purpose and Objectives

The objectives of the study were to explore future trends in proliferation and policy approaches for limiting proliferation. Specifically, the study assessed pressures for and constraints upon proliferation; delineated the possible scope and dynamics of proliferation; and characterized the potential parameters of Nth country nuclear programs and postures.

Timeframe Examined

1975 through1995

Prevailing Context

The study was initiated and carried out in the immediate aftermath of India's May 1974 nuclear test. Other important proliferation-related developments at that time included: the entry-into-force of the Treaty on the Nonproliferation of Nuclear Weapons (NPT) in 1970; concerns about the supply of sensitive reprocessing and enrichment equipment to third

world countries; the creation of the Zangger Committee aimed at regulating the international nuclear supply under the NPT; and continued concerns about the nuclear activities of Israel and South Africa. More broadly, the strategic nuclear arms control process involving the United States and the Soviet Union had begun.

Methodology: Alternative Futures-Proliferation Chains

Instead of examining future proliferation trends via a series of country-by-country case studies, the authors developed a set of fifteen proliferation futures. The purpose of these alternative futures was not to "predict the future" but to bound the range of plausible possibilities while identifying the dynamics of the proliferation process. Each of these alternative futures comprised one or more proliferation chains, linking together specific countries in light of each country's proliferation incentives-disincentives, the impact of different proliferation-related events in causing or hindering proliferation amongst a number of states, and potential proliferation "tipping points." Both external security-prestige related considerations and internal domestic political-bureaucratic factors – as well as the role of proliferation triggering events, momentum, and shocks – were set out as proliferation drivers.

Key Projections/Forecasts

The authors note that their alternative futures are not meant to be predictions of what will occur. Rather the different proliferation chains are intended to facilitate the analysis of future proliferation trends and dynamics, thereby shaping policy actions and choices to prevent more widespread proliferation. Thus, the discussion explicitly considers the factors or conditions that could lead to each particular outcome.

Projection 1:

Limited but steady proliferation to 1995: Every five years, additional countries "go nuclear" either overtly or covertly.

Projection 1A, Proliferation Phase

International constraints against proliferation are reinforced by the international community. As a result, proliferation is significantly reduced with only a few other countries after India acquiring nuclear weapons – either covertly or by claiming to have a peaceful nuclear explosives program.

Projection 1B, Suppressed Proliferation Following the Use of Nuclear Weapons

An initial late 1970s-early 1980s spurt of proliferation in Asia is followed by the first use of nuclear weapons since WWII. The United States, the Soviet Union, and the rest of the international community band together to suppress any further nuclear proliferation.

Projection 2, Early to Mid-1980s Latin American Proliferation

Rapid and extensive proliferation in Latin America occurs, with Brazil and Argentina leading the Latin American arms race. The study also projected that a Latin American nuclear arms race could lead to several other states in other regions to develop nuclear weapons as well.

Projection 3, Libyan-Triggered Early 1980s Middle East Proliferation
After Libya acquires nuclear weapons in the early 1980s, either by purchase or theft, the rest of the Middle East begins to build nuclear weapons. This, in turn, increases proliferation momentum around the world.

Projection 3A, Limited, Early to Mid-1980s Proliferation in Europe (No European Nuclear Force)
Following proliferation in Asia and the Middle East, proliferation occurs in Europe. Italy and Spain both acquire nuclear weapons. However, West Germany does not for both internal and alliance reasons.

Projection 4, Early to Mid-1980s Emergence of a Nuclear Exports "Grey Market"
A grey market emerges in nuclear supply, resulting in a general breakdown of supplier restraint and very extensive proliferation.

Projection 5, More Extensive Mid-1980s Global Proliferation: Repercussions of Growing Perceptions of American Unreliability
This projection assumed that the United States comes to be seen as an increasingly unreliable ally, resulting in increased nuclear proliferation.

Projection 6, Explosive Late 1980s-Early 1990s European Proliferation: A West German Nuclear Weapons Program
Proliferation in other regions as well as an erosion of the American security guarantee lead to a West German decision to build nuclear weapons. Efforts to create a European Nuclear Force prove abortive and as a result, a small group of West German officials arranges for covert participation in and assistance to an emerging Brazilian or South African nuclear program. Eventually, the nonproliferation regime breaks down and the suppliers market is essentially uncontrolled.

Projection 7, Widespread Mid-to-Late 1980s Proliferation in Asia: Japan "Goes Nuclear"
In what the study labels a proliferation turning point, Japan seeks nuclear weapons motivated by a mixture of heightened perceived vulnerability, nationalism, proliferation momentum and status, and U.S. disengagement. After Japan reveals its nuclear weapons, several other Asian nations are pressured to proliferate, and the nonproliferation regime sharply erodes.

Projection 7A, Asian-Influenced Late-1980s Middle East Proliferation
Proliferation in Asia creates a proliferation chain in the Middle East, partly linked to the impact of a Japanese decision to acquire nuclear weapons eroding the NPT system overall.

Projection 7B, Asian-Influenced Late 1980s-Early 1990s Proliferation in Europe
Another variant on Projection 7, Japan's nuclear weapons program heightens pressures on several European states to acquire nuclear weapons. In turn, West Germany acquisition of weapons to triggers Italy, Spain, Sweden and Switzerland to follow.

Projection 8, Late 1980s Erosion of Technological Constraints and the NPT System
Technological constraints are seen in this projection to have been eroded as new enrichment technologies become easier to engineer and build and safeguards are routinely violated with no consequences. The scope and pace of proliferation are very significantly increased in a world of widespread proliferation.

Projection 9, Mid- to Late 1980s Proliferation in Eastern Europe
Yugoslavia and then Romania acquire nuclear weapons.

Projection 10, Widespread, Multi-Regional Chain Reaction Proliferation to 1995
The authors viewed this projection as a means to show how the interaction of specific trends and events highlighted in their earlier futures could result in a world of runaway proliferation with multiple nuclear arms races across all the world's regions.

Other Major Conclusions and Unique Dimensions

Proliferation Turning Points
The study highlighted a number of potential proliferation "turning points," including:

- Sale or gift of a nuclear weapon;
- Use of a nuclear weapon;
- Withdrawal from the NPT;
- Emergence of a nuclear-exports grey market;
- Widespread dissemination of nuclear enrichment technologies;
- Sharp reduction in U.S. alliance credibility;
- Breakdown of NPT system; and
- Unsuccessful or ineffective application of sanctions following a safeguards violation.

Proliferation Characteristics
The study included an extensive discussion of the potential parameters of Nth country nuclear weapon programs and postures. This discussion focused on critical technical characteristics, issues of doctrine and command and control, and survivability. Different possible Nth country nuclear doctrines and postures were set out.

Impacts of Proliferation
The impacts of proliferation in terms of regional arms races, new dangers, and global competitiveness were explored. The potential impacts that proliferation could have on intensifying domestic political conflict were considered, including the "nuclear coup d'etat."

Policy Implications

The report included a set of policy recommendations to prevent the more dangerous proliferation projections from coming to pass. The authors noted the importance of reinforcing constraints placed upon potential Nth countries and reducing the pressures to go nuclear. The study also included a discussion of U.S. actions to manage the problems of proliferation, influencing the postures and policies of new proliferators, contributing to regional stability, and containing global repercussions.

Assessment

Which aspects of the study stood the test of time (i.e. came true)? Which aspects have not?

Overall Projections

As the authors' noted, the purpose of the projections was not to predict future proliferation but to help understand its potential dynamics and drivers as well as support the efforts of U.S. policy to shape the proliferation future. Nonetheless, the experience of the next two decades suggests that there may well be more internal constraints on national decisions to acquire nuclear weapons than suggested by the type of "rational" model set out here. At the least, the overall pressures for proliferation – if not the momentum and chain reaction effect – was considerably less than anticipated.

Proliferation Drivers

The study's emphasis on a broad set of proliferation drivers, including both external factors and internal developments, proved to be a solid framework for thinking about proliferation in the ensuing decades. In turn, its broad emphasis on the importance of proliferation turning points or shocks proved correct. By the early 1980s, its projection of a "grey market" involving clandestine purchases, shadowy suppliers, and networks of illicit trade had definitely emerged. This "grey market" would be formalized a decade later in the A.Q. Khan network.

Countries of Critical Proliferation Concern

The study identified the following countries as being "critical potential Nth countries" in terms of the impact a decision by any one of them *not* to acquire nuclear weapons could have on the scope and pace of further proliferation: Argentina, Brazil, India, Iran, Israel, Japan, Libya, Pakistan, South Korea, Taiwan, and West Germany. For each, the study examined pressures for proliferation, most critical constraints, and triggering events. In the decades after the study, Israel, India, and Pakistan did build nuclear weapons. Libya sought to do so but lacked the technical capabilities needed. Iran, Argentina, and Brazil either considered or began nuclear weapons programs but then stopped for differing reasons – all of which included wild card changes of regimes. Both South Korea and Taiwan also considered

resuming their nuclear weapon pursuits but were stopped by American pressure. Japan and West Germany remained committed to their non-nuclear status, in part for reasons identified in the study (e.g., the U.S. security guarantee).

Did the particular methodology used influence what the study "got right" and what it "got wrong"? How replicable is the methodology? Can it be employed by others?
The alternative futures-proliferation chains methodology proved a valuable means to explore proliferation dynamics. However, it may have a built-in bias toward exaggerating the scope of future proliferation. The emphasis on proliferation triggering events or tipping points also proved useful to explore proliferation dynamics. However, the study underestimated the role of such events or tipping points – leading to slowing proliferation or the roll-back of nuclear weapons programs. Further, though the study did identify the importance of internal bureaucratic factors as well as technical momentum, in some cases it may have underestimated the importance of these factors.

The alternative futures-proliferation chains methodology is replicable. It would be important, however, to combine it with more in-depth country expertise to refine any projections.

Was the study influential in some way? If so, how and why? What factors led decision-makers to take notice of it?
The study reinforced the efforts already underway to strengthen suppliers' controls. It also contributed to ongoing thinking within the government on nonproliferation policy. Its emphasis on managing proliferation proved controversial.

Was the study itself influential in changing the course of events, (i.e., did policy intervention result in some aspects of the study being proven wrong)? Or did other external factors change the outcome?
Over the two decades covered by the study, continuing policy actions by the United States – and in many instances other countries – often served to increase the constraints and reduce the pressures that could lead to proliferation decisions. The continued vitality of U.S. alliances, the emergence of the Nuclear Suppliers Group and the strengthening of international norms and institutions all are examples. The study's alternative projections highlighted the importance of such actions. Still other external developments and wild cards contributed to "negating" some of the more expansive projections. Changes of leadership in Iran, Argentina, and Brazil are three examples of wild card changes. At the same time, the Soviet invasion of Afghanistan led to U.S. decision to come to terms with Pakistan's pursuit of nuclear weapons; lest it lose the support of that ally in the 1980s during its efforts to defeat the Soviet Union.

Intelligence Community Experiment in Competitive Analysis: Soviet Strategic Objectives – An Alternative View

Richard Pipes, William Van Cleave, Daniel Graham, Thomas Wolfe, John Vogt
In Report of Team B, *1976*

Overview

The "Team B" report relied on the professional expertise of its members to conduct an alternative assessment of the data and resulting National Intelligence Assessments of Soviet strategic goals from 1962-1975. As such, it came to epitomize a methodology of bringing in outside experts to do an independent, alternative assessment of a tough national security problem – in effect, a "Team B analysis." This "Team B" assessment concluded that past analyses of Soviet goals were seriously flawed: both underestimating a Soviet pursuit of global hegemony as the core of its grand strategy and assuming that Soviet strategic nuclear thinking "mirror imaged" that of the United States. The resulting "Team B" report influenced the ongoing U.S. official and unofficial debate about Soviet goals and policies in the late 1970s. More important, it shaped the thinking and actions of the future Reagan Administration. Though the conclusions put forward remain controversial, the basic "Team B" approach of an independent outside assessment has become an accepted analytic tool.

Commissioned By

The Director of Central Intelligence, on behalf of the President's Foreign Intelligence Advisory Board.

Purpose and Objectives

To provide an independent examination of the data that go into the preparation of the National Intelligence Estimates (NIEs) and on that basis determine whether or not Soviet strategic objectives are more ambitious than they appear to the authors of the NIEs. The report focuses on Soviets intentions not simply a review of their technical capability.

Timeframe Examined

The focus of the report is the set of NIEs from 1962-1975. There are also references to the beginnings of the Soviet state in 1917 and the beginning of the Soviet nuclear era in 1949.

Prevailing Context

On the one hand, the early to mid-1970s were the era of U.S.-Soviet détente. This period included summits between President Richard Nixon and Soviet Premier Leonid Brezhnev and later between President Gerald Ford and Brezhnev. The Anti-Ballistic Missile (ABM) Treaty and Strategic Arms Limitation Treaty (SALT I) Interim Agreement were signed and entered into force in 1972. The 1975 Vladivostok Accord appeared to augur further strategic arms limitations. On the other hand, there was a strong – if minority – U.S. opposition to this process of détente as well as to the nuclear arms control process.

Conservative critics from both parties argued that the Soviet Union was gaining unilateral advantage and was seeking strategic nuclear superiority.

Methodology: "Team B" – Historical Analysis-Expert Judgment

These individuals were established intentionally to provide a "Team B" assessment of Soviet strategic intentions. Drawing on qualitative insights and professional expertise on the Soviet Union, the team of analysts performed two tasks: first, the authors re-examine the data gathered for the 1962-1975 NIEs with a focus on why certain data (quantitative and technical) was emphasized in those reports and other information (human intelligence and other "soft" data) was not included. To do this, they critically analyzed ten NIE reports and other drafts section by section. The authors offer their own assessment of Soviet strategic objectives, based on their wider view of Soviet history and intelligence, a view that was incorporated in to the original NIEs. Their approach was not unique. It was intended to address what the authors saw as a perceived shortcoming in the NIEs – too little attention to the role of Soviet strategic objectives in formulation of broader Soviet strategy.

Key Projections/Forecasts

The main finding is that analyses of Soviet behavior in the NIE report were seriously flawed for two reasons. First, the NIE's "mirror-imaged" when determining Soviet strategic intentions – assuming that Soviet political, economic and military intentions were the same as (or mirror-images of) U.S. intentions. Second, the NIE was focused on "hard" data such as technical assessments and generally excluded "soft" data like human intelligence and judgments based on the broader political background of Soviet behavior. The authors then formulated their own estimate of Soviet strategic objectives:

- *Soviet "Grand Strategy"*: Available political, economic, and military evidence pointed to a Soviet desire for hegemony. The Soviet Union sought to both weaken Western capitalism and strengthen Soviet socialism.

- *Soviet Military Strategic Objectives*: The Soviet Union was striving for effective, strategic superiority in all branches of the military, including nuclear forces. Further, Soviet leaders were not concerned with Western ideas of "mutually assured destruction," but were instead concerned with "war fighting" and "war winning" capabilities. With this in mind, efforts like détente and the SALT arms control process were not seen by the Soviets as cooperative efforts, but rather as means of competing more effectively with the United States.

Assessment

Which aspects of the study stood the test of time (i.e. came true)? Which aspects have not?

This is difficult to judge because the goals and strategies of the former Soviet Union remain controversial to this day. Moreover, specific Soviet military and technical choices of that era also are subject to differing interpretations, e.g., the steady expansion of its nuclear posture, its investment in "heavy" missiles – each capable of carrying a large numbers of nuclear warheads, and shortly afterwards, its deployment of SS-20 intermediate-range missiles in Eastern Europe.

At the same time, other Soviet actions of the time lend credence to this more skeptical assessment of Soviet goals, not least the 1979 Soviet invasion of Afghanistan. Moreover, some evidence that has come to light in the aftermath of the collapse of the Soviet Union can be cited in support of the "Team B" assessment, including the fact that not until after the 1986 Chernobyl nuclear plant accident did the Soviet military leadership fully accept that a nuclear war cannot be won. Suffice it to conclude that at the least, the Team B report's assessment stands as a valuable counter-point to the more optimistic assessment at the time of Soviet goals.

Did the particular methodology used influence what the study "got right" and what it "got wrong"? How replicable is the methodology? Can it be employed by others?

The methodology relied on qualitative judgment and professional expertise to examine various data sources and past documents. Given the authors' backgrounds and previous writings – and their task of reassessing previous NIEs – they had an acknowledged inclination to second-guess earlier assessments. From another perspective, however, it is less a question of what the "Team B" assessment "got right" or "got wrong" than whether it served its purpose of challenging the assumptions and analysis of past NIE's on Soviet goals and policies. For that purpose, use of a set of outsiders would have been essential.

This type of "Team B" analysis can be readily replicated in other instances as a means to examine established assumptions, cause analysts to reassess data from different perspectives, and most of all, challenge long-standing analytic mindsets. Such "Team B" analysis, however, cannot replace ongoing efforts to implement a balanced approach.

Was the study influential in some way? If so, how and why? What factors led decision-makers to take notice of it?

Substantively, the "Team B" assessment contributed to an ongoing debate in the late 1970s about Soviet goals and intentions. Its arguments appeared to have been partly validated by the Soviet 1979 invasion of Afghanistan. It also directly fed into the conceptual thinking and assumptions of the Reagan Administration.

Analytically, the "Team B" assessment provided a continuing example of the use of outsiders to carry out an independent assessment of a tough issue. As such, the "Team B" methodology was re-used in the ensuing decades, sometimes informally and sometimes more formally as in the 1998 assessment of the ballistic missile threat carried out by former Secretary of Defense Donald Rumsfeld.

Was the study itself influential in changing the course of events (i.e., did policy intervention result in some aspects of the study being proven wrong)? Or did other external factors change the outcome?

The "Team B" assessment directly influenced the thinking and actions of the Reagan Administration. Several of its authors directly advised that Administration, including President Reagan himself. As such, their arguments contributed to new U.S. initiatives to confront the Soviet Union in Afghanistan, to buttress U.S. strategic and other military capabilities, and to resist Soviet power in Europe and globally. Taken alone, this greater American readiness to confront Moscow's ambitions would not have sufficed to bring about the changes that led to the eventual end of the Cold War. Political change in the Soviet Union with the rise to power of Mikhail Gorbachev (seeking to reform Soviet communism) and the role of U.S. Presidential leadership (in President Reagan's commitment to working with Gorbachev) were also critical to the eventual outcome.

Swords from Plowshares – The Military Potential of Civilian Nuclear Energy

Albert Wohlstetter and Henry Rowen, eds.
Chicago: University of Chicago Press, 1979

Overview
The core of this study uses a trends analysis methodology to extrapolate future global use of nuclear energy, accessibility of stockpiles of fissile material, and resultant dangers of widespread proliferation. Focused on the 1980s and 1990s, it forecasts a growing danger of widespread proliferation arising out of a projected spread of civilian nuclear energy and fissile material to 40 plus states. Its projections were confounded by a radical and unanticipated shift away from nuclear energy that ensued in the decade after its publication, not least due to the occurrence of two wild card events – the nuclear power plant accidents at Three Mile Island and Chernobyl. As nuclear power gains credibility as a critical energy source, the study's concerns warrant attention and international policy actions. In that regard, this study typifies the fact that some forecasts may be proven wrong for their particular time and place but may eventually warrant renewed attention.

Date
1979 – Based on earlier report "Life in a Nuclear-Armed Crowd" undertaken in 1975 for the U.S. Arms Control and Disarmament Agency.

Authors
Albert Wohlstetter, Thomas A. Brown, Gregory S. Jones, David McGarvey, Henry Rowen, Vince Taylor, Roberta Wohlstetter.

Commissioned By
This book stemmed from an earlier report prepared for the U.S. Arms Control and Disarmament Agency in 1975.

Purpose and Objectives
The authors intended to raise questions for policy makers about the spread of civilian nuclear technology and how that technology may contribute to the spread of nuclear weapons.

Timeframe Examined
The future of proliferation from 1975 onward, with forecasts for 1985 and 1990.

Prevailing Context
India's 1974 nuclear test had created growing concern among U.S. officials that a second-wave of nuclear proliferation was about to commence. There were many reasons for this concern. West Germany appeared prepared in 1975 to sell Brazil a full nuclear fuel cycle. France's proposed 1975 sale of a reprocessing plant to Pakistan – as well as that country's

pursuit of nuclear weapons – intensified this concern. Though ultimately these deals did not go forward, there remained uncertainty about whether the newly-created (1977) Nuclear Suppliers' Group would be able to contain the spread of sensitive technologies around the globe. In turn, South Africa's pursuit of nuclear weapons was commencing, while in Asia both Taiwan and South Korea had initiated nuclear weapons programs only to be forced by U.S. pressures to give them up. Not least, there was a strong belief yet again that the 1980s and 1990s would witness a steady and unabated expansion of the use of nuclear energy around the globe. There was intense debate in the United States and overseas about whether that expansion would include widespread reprocessing of spent nuclear fuel to separate out the plutonium for either recycling in light-water reactors or use in breeder reactors.

Methodology: Trends Analysis-Quantitative Analysis

The primary methodologies are trends analysis and quantitative modeling. The former is used to develop projections for the global use of nuclear energy. The latter is relied on to develop forecasts of the possible future stockpiles of fissile material countries and these countries' resultant potential to produce nuclear weapons. The authors also perform quantitative modeling is done of the economics of nuclear energy – examining various aspects of building and maintaining nuclear power as opposed to reliance on fossil fuels and other sources of energy. Linkages between civilian nuclear technologies and weapons production are described.

Key Projections/Forecasts

Drivers of Future Proliferation

The main projection – and the core of the study's argument – relates to the future production and accessibility of fissile material around the globe. The authors predicted that by 1985, forty states would have enough fissile material from their civilian nuclear energy programs to make three or more nuclear weapons. As a result, the study argues that while there was a linear trend of slow proliferation growth from 1945 to 1974, the Indian nuclear test in 1974 likely marked a turning point. Henceforth, the spread of fissile material – or what they call the "nuclear overhang" could lead to the exponential growth of nuclear weapons states.

In addition, the study finds that this trend toward a global spread of civilian nuclear technology will result in a proliferation of sources of supply. Thus, it will become much more difficult to restrict access to specific nuclear weapons or dual-use technologies. A single state or small group of states – typified by the Nuclear Suppliers Group – will not have the same power to deny access as they did before the spread of civilian nuclear energy.

Nuclear Instabilities and Risks

In a confrontation between a large nuclear state and a small nuclear state, the large state would have the ability to destroy the small state but the small state would not have the ability to destroy the large state. Nonetheless, the smaller state may have slightly increased bargaining power but not to a significant degree. The study conditions this judgment by

noting that very rarely do two states deal with each other in a vacuum – there are almost always other states involved in alliances or negotiations.

Nuclear arms racing can be the result of proliferation involving two "lesser powers" such as China and India, India and Pakistan, or Iran and Iraq. In these cases, a nuclear arms race could lead to great instability regionally.

As thirty or forty states come into possession of fissile material, more proliferation will occur. The result likely will be instability in the international system as states compete with each other. Nuclear accidents and dangerous alliances will become more likely. In turn, the continuing spread of materials – and potentially weapons – could lead to attack with nuclear weapons by an extra-governmental group, e.g., a radical group taking over in a *coup d'état*.

Over time, the taboo against possessing and using nuclear weapons will weaken.

Assessment

Which aspects of the study stood the test of time (i.e. came true)? Which aspects have not?

The Spread of Fissile Material

The study's main forecast was that an exponential growth of civilian nuclear energy use would lead first to widespread stockpiles of readily accessible fissile material and then to more nuclear weapons states.

Comment: This forecast proved wrong during the timeframe of the study. By the early 1990s, there had not been an exponential growth in the use of nuclear energy or the presence of separated fissile material. Moreover, the number of nuclear weapons states or countries pursuing nuclear weapons remained much the same as what it had been in 1979. (See below for a discussion of what confounded the study's prediction of a global trend toward nuclear energy use and separation of fissile material during the 1980s and 1990s.) However, the world appears to be facing a similar turning point at present (in 2008): as in 1979, global energy consumption is rising incredibly quickly, projections are being made of many states turning to nuclear energy to fill the gap in their energy supply, and it remains to be determined whether it will be possible to avoid the spread of national enrichment and reprocessing capabilities as well as stockpiles of separated fissile materials.

Difficulties Restricting Supply

The study projected that the spread of civilian nuclear technology would make restricting access to nuclear or dual-use technologies much more difficult.

Comment: Nuclear suppliers' cooperation was steadily strengthened over the two decades after the study. The Nuclear Suppliers Group lists were strengthened and there were no

further offers to sell sensitive technologies. Covert access to sensitive technology and gray market supply was a challenge – but one that was not linked to a global spread of civilian nuclear activities. Indeed, the most serious challenge during this period – and now – to controlling the spread of nuclear technology – the A.Q. Khan supply network – had little to do with civilian nuclear energy use. A.Q. Khan came out of the Pakistan nuclear weapons program. (Nonetheless, from today's vantage point, as more countries come to use nuclear energy, there will be more potential sources for gray market or illicit supply. Even here, however, the issue remains of whether new international efforts to meet that challenge under United Nations Security Council Resolution 1540 will be successfully implemented or not.)

Nuclear Instabilities

As predicted, an emerging nuclear arms race between India and Pakistan in the 1990s arguably led to greater instability in that region. But so far, nuclear accidents have been avoided and the taboo against using nuclear weapons is still intact – even if the taboo against possessing nuclear weapons has seemingly weakened. In turn, concern has increased about possible terrorist or rogue regime use of a nuclear weapon, not least given the combination of fundamentalist terrorism and unrest in a nuclear-armed state such as Pakistan.

Did the particular methodology used influence what the study "got right" and what it "got wrong"? How replicable is the methodology? Can it be employed by others?

The methodology of extrapolating trends directly led to the study's exaggerated forecast of future global use of nuclear energy and stockpiles of fissile material for the period in question (1980s and 1990s) – the key steps to its forecast of a great danger of more widespread proliferation. That extrapolation, however, was undermined by a number of factors: the very changing economics of nuclear energy use that the study highlighted, the technical difficulties of recycling plutonium or developing breeder reactors, heightened domestic opposition in many countries to nuclear energy use on multiple grounds, the success of the Nuclear Suppliers' Group and U.S. efforts to buttress nuclear export controls, and not least two critical wild cards – nuclear power plant accidents first at Three Mile Island (1979) and Chernobyl (1986). Nonetheless, as the possibility of growing use of nuclear energy again looms on the horizon, the dangers forecast by the study will need to be addressed yet again.

Trends analysis can readily be replicated as part of an overall forecast of proliferation futures. As with this study, it risks being confounded by future events that may or may not be foreseeable.

Was the study influential in some way? If so, how and why? What factors led decision-makers to take notice of it?

Undertaken for the Director of ACDA (Dr. Fred Ikle), the initial study – "Life in a Nuclear-Armed Crowd" – directly contributed to the Carter Administration's policies. In particular, along with several other analyses, the study provided the conceptual basis for the U.S. initiative to encourage other countries not to use plutonium as part of their nuclear energy programs in what was called the International Nuclear Fuel Cycle Evaluation (INFCE). This study also reinforced the U.S. policy commitment to create the Nuclear Suppliers Group, with its commitment that suppliers should exercise restraint in the transfers of sensitive enrichment and reprocessing technologies.

Was the study itself influential in changing the course of events, (i.e., did policy intervention result in some aspects of the study being proven wrong)? Or did other external factors change the outcome?

The Carter Administration's efforts to influence other countries' nuclear energy choices consistent with the study's assessments proved unsuccessful. Instead, the external factors noted above played the greatest role in leading to much less global use of nuclear energy – and thus, less access to fissile materials – than this study forecast. Most of all, the wild cards of nuclear energy accidents played a key part.

The Dynamics of Nuclear Proliferation

Stephen M. Meyer
University of Chicago Press, 1984

Overview

This book develops and applies a quantitative model to forecast future proliferation risk. To do so, the author identifies and defines three risk factors – time lag (to a first nuclear weapon), nuclear propensity (reflecting the interaction of technical and motivational factors), and salience (impact on regional stability and conflict). For a set of 36 countries known to have had an interest in seeking nuclear weapons, a Delphi method of surveying experts is used to rank the risk factors. This approach provides a useful way of summarizing considerable data in a proliferation risk factor index and then comparing different countries. However, in contrast to the more traditional country case study methodology, the Delphi method may sometimes result in experts with only limited knowledge of one or more countries ranking that country in terms of the factors identified. As a result particular rankings may be either underestimated or overestimated. Domestic political, economic, bureaucratic, and cultural "internal" factors also are not broken out as a separate risk factor, though these have since proven very important in proliferation decision-making.

Purpose and Objectives

According to the author, this book undertakes a rigorous and systematic examination of the assumptions and contending hypotheses that constitute contemporary thinking on nuclear proliferation. According to the author, his objective is to develop a better picture by using the various schools of thought as analytical windows. He hopes that a better understanding of how the proliferation process operates will offer better guidance for predicting future nuclear proliferation and, ultimately, for controlling it.

Timeframe Examined

1982 – 1987 (five years)

Prevailing Context

The Meyer Study was carried out in a period from the mid-1970s into the early 1980s of sustained controversy among experts and officials about the causes of proliferation. Two contending schools had emerged: one emphasized the role of technology in pushing proliferation; the other emphasized the role of incentives in pulling countries toward the bomb. This period was also characterized by major shifts in U.S. policies, exemplified by the passage of the 1978 Nuclear Non-Proliferation Act (which set out tougher standards for U.S. peaceful nuclear cooperation with other countries) as well as by the Carter Administration's proposed international evaluation of nuclear fuel cycle alternatives and then by the efforts of the Reagan Administration to modify restraints on such cooperation. On the international front, the Reagan Administration was moving to confront the Soviet Union after its invasion of Afghanistan, while Pakistan was continuing to advance toward nuclear weapons. In May

1981, Israel bombed an Iraqi research reactor intended by Saddam Hussein to be part of Iraq's nuclear weapons program.

Methodology: Quantitative Modeling with Delphi Method Inputs

The author develops a formal quantitative forecasting model to help determine the relative likelihood (or risk) that countries will make proliferation decisions and subsequently acquire nuclear weapons within a fixed time frame. Three risk factors are defined and then used in this model: *nuclear propensity*, *proliferation salience*, and *time lag*. These three factors are defined as follows:

Lag Time

The amount of time required after a proliferation decision is made to produce the first nuclear weapon:

1. Short: takes a short amount of time (possibly within one year).
2. Moderate: takes more time (up to four years). "There is some 'breathing room' between a proliferation decision and the initial output of nuclear weapons."
3. Long: takes longer (longer than six years).

Nuclear Propensity

The dynamic convergence between technical and motivational factors that lead a country to develop nuclear weapons: [1]

1. Strong: may lead a country to make a decision to proliferate.
2. Moderate: may cause a country to develop a nuclear option building.
3. Weak: may not cause nuclear proliferation to become a serious policy issue.

Salience

The expected impact on regional stability and conflict and on further proliferation:

1. High: has a great affect on regional stability and will probably cause further proliferation.
2. Moderate: has an affect on regional stability, but may or may not cause further proliferation.
3. Weak – may affect regional stability and follows all proliferation norms.

For each of 36 countries known to have had interest in developing nuclear weapons at some time, the author assigns numerical values to each factor. This allows the creation of a country-specific *risk factor* index comprised of that country's score on each of these three separate factors. In scoring each country, the study relies partly on an expert judgment Delphi methodology to judge proliferation salience in light of specific criteria identified by

[1] A strong nuclear propensity – or perhaps even a moderate nuclear propensity – is sufficient to motivate a government to dedicate resources specifically to acquiring a latent capacity; that is, to make a capability decision. Once a latent capacity is acquired, and should strong motivations persist, a proliferation decision – an explicit decision to proceed with nuclear weapons development and production – should follow.

the author. Rankings are from 1-3 with a "1" in lag time indicating the "shortest", a "1" in nuclear propensity indicating the "highest", and a "1" in salience indicating the "highest".

Further, the methodology also highlights the convergence between the technical and political aspects of the nuclear proliferation process – rather than focusing on either aspect to the exclusion or detriment of the other. Based on the country indices, the study goes on to explore categories of technical-motivational interaction.

Key Projections/Forecasts

Impacts of Proliferation:
In terms of *salience*, the consequences of proliferation could be seriously destabilizing in 64 percent of the cases examined. Proliferation decisions by Japan, the Federal Republic of Germany, Israel, Pakistan, Yugoslavia, South Korea, Egypt, Iran, Libya, Iraq, North Korea, and Cuba would have high salience. Decisions by Algeria, Argentina, Brazil, Chile, German Democratic Republic, Greece, Mexico, Nigeria, South Africa, South Korea, and Taiwan, and Yugoslavia would have moderate salience.

Time to the Bomb
In terms of *lag time* the author finds that 58 percent of the 36 countries examined could be producing nuclear weapons within four to five years of his writing. In particular, Argentina, Belgium, Canada, Federal Republic of Germany, Israel, Italy, Japan, the Netherlands, South Africa, and Spain have short lag times, and Austria, Brazil, Czechoslovakia, German Democratic Republic, Norway, South Korea, Sweden, Switzerland, and Yugoslavia have moderate time lag.

Nuclear Propensity
In terms of *nuclear propensity,* about thirty percent of the countries examined "seem to have some interest in acquiring nuclear weapons." Specifically, six countries including South Africa, Israel, Pakistan, Iran, Libya, Iraq, and Algeria have a high propensity to proliferation. Five of the 36 have a moderate propensity to proliferate. These include Japan, Taiwan, South Korea, Egypt, and Nigeria.

Country Specific Assessments (in alphabetic order)
The table below summarizes the country assessments.

Country/Risk Factor Index	Short Lag time (1 = shortest)	Nuclear Propensity (1 = highest)	Salience (1 = highest)	Country/ Risk Factor Index	Short Lag time (1 = shortest)	Nuclear Propensity (1 = highest)	Salience (1 = highest)
Algeria	3	1	2	Italy	1	3	3
Argentina	1	1	2	Japan	1	3	1
Australia	3	3	3	Libya	3	1	1
Austria	2	3	3	Mexico	3	3	2
Belgium	1	3	3	Netherlands	1	3	3
Brazil	2	3	2	Nigeria	3	2	2
Canada	1	3	3	North Korea	3	3	1
Chile	3	3	2	Norway	2	3	2
Cuba	3	3	1	Pakistan	2	1	1
Czechoslovakia	2	3	3	South Africa	1	1	2
Egypt	3	2	1	South Korea	2	2	2
FRG	1	3	1	Spain	1	3	3
Finland	3	3	3	Sweden	2	3	3
GDR	2	3	2	Switzerland	2	3	3
Greece	2	3	2	Taiwan	2	2	2
Iran	3	1	1	Turkey	3	3	2
Iraq	3	1	1	Yugoslavia	2	3	2
Israel	1	1	1				

Assessment

Which aspects of the study stood the test of time (i.e. came true)? Which aspects have not?

Overall, the study's assessment of proliferation risk for different countries proved accurate. However, there were several cases in which it either underestimated or overestimated particular rankings:

In addition, there are a number of other country-specific judgments that warrant mention:

Argentina (Risk Factor Index – 1-1-2)
". . . the convergence of motivation with the capability implicit in Argentina's advanced nuclear infrastructure should see a proliferation decision followed by a first Argentine nuclear weapon operational within several years of such a decision."

Comment: Argentina's program moved more slowly than suggested both in terms of political commitment and technical advances.

Belgium (Risk Factor Index – 1-3-3)

Comment: Focusing only on Belgium's civilian nuclear program may result in an overestimate of its technical capabilities.

Brazil (Risk Factor Index – 2-3-2)
Brazil's nuclear propensity is seen to suggest no serious interest in nuclear weaponry during the assessment period, but that country could be pushed to seek nuclear weapons were Argentina to do so.

Comment: Later public revelations showed that Brazil was more actively pursuing nuclear weapons capability at this point in time compared to Argentina.

Netherlands (Risk Factor Index – 1-3-1)
Very short lead time but little likelihood for shift to a higher propensity in the near term.

Comment: Again, focus on civilian nuclear infrastructure results in overestimation of technical capabilities.

North Korea (Risk Factor Index – 3-3-1)

Comment: A major misestimate in terms of nuclear propensity since North Korea was in the midst of a nuclear weapons program at this point in time. Accurate assessment of how long it would take, though even there, external constraints may have played a role.

Romania (Risk Factor Index – 3-3-3)

Comment: Revelations after the collapse of the regime suggested that Romania may have had a higher nuclear propensity than suggested.

Did the particular methodology used influence what the study "got right" and what it "got wrong"? How replicable is the methodology? Can it be employed by others?
The methodology entailed a quantitative model (with scoring for three proliferation risk factors) combined with use of a Delphi method of surveying analysts to determine specific ranking. The resulting risk factor index was a useful way to summarize and display analysts' assessments. Three possible ways that the methodology may have shaped the results warrant mention:

- First, reliance on a Delphi method depended on the detailed knowledge about many countries of the experts surveyed – and on the author's own knowledge of the full set of countries. But outside experts frequently have only partial knowledge of some specific countries and often are reluctant when asked to make a ranking judgment not to do so. Use of multiple analysts may sometimes neutralize that factor but not always. Use of the Delphi model may have resulted, therefore, in the study's underestimating of the nuclear propensity of several important countries.
- Second, the model's "lag time" index may have relied too heavily on status of peaceful nuclear activities as an indicator of how quickly a country could obtain a

nuclear weapon, underestimating the difficulty of weaponization activities even after possession of fissile material.

- Third, the model did not take into account either domestic political changes, economic orientation, or unanticipated "wild cards". In the latter case, this is not surprising given the difficulties of projecting such developments in advance let alone quantifying them. In contrast, domestic political support or constraints on proliferation are sufficiently important and might have been added as another explicit risk factor. By way of example, domestic political changes in Argentina, Brazil, and South Africa all contributed to shifts downward in nuclear propensity. More recently, economic orientation – whether a country's leaders are committed to an outward looking, globalist economic policy – has been identified as another factor shaping proliferation decisions.

Was the study influential in some way? If so, how and why? What factors led decision-makers to take notice of it?

There is no evidence that the study directly shaped U.S. proliferation decision-making in the mid to late 1980s. However, its emphasis on the need to focus on the interaction of technical and political factors likely contributed to a more general broadening of how experts and officials though about proliferation dynamics.

Was the study itself influential in changing the course of events, (i.e., did policy intervention result in some aspects of the study being proven wrong)? Or did other external factors change the outcome?

The study itself did not influence policy. However, U.S. and other countries' policy efforts did make it harder for some countries, e.g., both Argentina and Brazil, to move toward nuclear weapons.

The Dynamics of Nuclear Proliferation: Balance of Incentives and Constraints

In Memorandum 85-10001
National Intelligence Council, 1985

Overview

The National Intelligence Council (NIC) memorandum's methodology combines an historical assessment of prior National Intelligence Estimates (NIE) to identify lessons learned with country assessments. Looking back to the 1960-1980 period, it identifies a series of limitations of past reports. Most broadly, it noted that earlier fears of very widespread proliferation had proven to be unfounded. Those fears reflected a number of analytic judgments, including giving too much importance to technical developments, overestimating the spread of nuclear energy, and thinking in terms of a proliferation domino effects theory. Actions by the United States and other countries, such as creation of the Nuclear Suppliers Group as well as the growth of a norm of nonproliferation, were also seen as having contributed to negation of more pessimistic forecasts. Looking ahead in light of the lessons of past studies, the NIC memorandum emphasized that countries would be reluctant to deploy nuclear weapons openly, which was one feature of proliferation for over the next decade. It also highlighted the importance of internal political-cultural factors in exploring the possible pursuit of nuclear weapons by more xenophobic regimes. Technical forecasting continued, however, to prove difficult. The NIC memorandum appears to have underestimated technical advances in Brazil, North Korea, and Iraq. Unless not mentioned for reasons of classification level, this memorandum appears to have missed what would be one of the most important proliferation wild cards from the mid-1980s onward – the emergence of the non-state actor A.Q. Khan proliferation network.

Purpose and Objectives

This study is a historical critique of NIE accuracy in predicting proliferation trends. It analyzes proliferation decision-making over the preceding twenty years to assess the balance of incentives and disincentives to proliferation. It also points out significant events that may have been influential in nonproliferation efforts.

Timeframe Examined

1960 to 1980 (twenty years). Future predictions extended for five and ten years from the time of the study, from 1990-1995.

Prevailing Context

In the Cold War context, the United States was actively engaged in covert activities to support the Mujahideen forces that eventually would force the withdrawal of the Soviet Union from Afghanistan. U.S.-Soviet relations were tense, following the successful U.S. deployment of cruise missiles and Pershing missiles to Europe and the Soviet walk-out from nuclear arms control talks. In terms of proliferation, Pakistan's clandestine nuclear weapons

program continued to advance, while India tested a so-called peaceful nuclear explosion in 1974. In 1981, Israel bombed the Osiraq nuclear reactor in Iraq. North Korea's nuclear weapons program had only recently become a major focus of U.S. nonproliferation policies.

Methodology: Historical Assessment (Lessons Learned)-Country Case Studies

This study is a historical analysis in which the authors critically evaluate earlier National Intelligence Estimates and relevant papers on proliferation to assess whether or not past predictions have withstood the test of time. The authors propose their own predictions/projections based on lessons learned from the past. In so doing, they focus on a wider set of multiple variables, explicitly criticizing both the technology push and the proliferation chains concepts. Domestic political-economic-cultural-regime factors are explicitly considered. This assessment also took into account the impact of changes in the overall regime that had been partly animated by past fears of more widespread proliferation, e.g., the impact of nuclear suppliers' restrictions on transfers of sensitive nuclear fuel cycle components and facilities.

Key Projections/Forecasts

Judgments on Past NIE Assessments

The 1985 NIC assessment argues that past NIE reports all had certain weaknesses or limitations. Specifically, past reports:

- Were too fearful of additional overt proliferation, with no other country overtly deploying nuclear weapons since China's 1964 nuclear test;
- Gave as much importance to technical capability as to the political, security, and economic situations, often overemphasizing the extent to which technical capability and expertise will drive nuclear proliferation;
- Frequently referred to proliferation as being a result of a domino effect theory, resulting in a exaggerated concern about the inevitability of proliferation;
- Did not sufficiently analyze the implications of important proliferation events or shocks such as the Indian 1974 nuclear test; and,
- Did not have a clear definition of proliferation.

At the same time, the NIC assessment notes that past NIE reports also accurately assessed the status of nuclear weapons programs in Pakistan, South Africa, and North Korea. The NIC assessment further notes that earlier assessments could not take into account the impact of various changes in global nonproliferation efforts over the period from 1960-1990, some of which were encouraged by the more pessimistic earlier forecasts, e.g., U.S.-NATO nuclear burden sharing, negotiation of the Treaty on the Nonproliferation of Nuclear Weapons (NPT), and the creation of the Nuclear Suppliers Group.

Country-Specific Forecasts

Pakistan

The 1985 NIC assessment argues that Pakistan's pursuit of nuclear weapons is the greatest concern in terms of U.S. interests. The study assesses that Pakistan's nuclear decisions will continue to be shaped by its continuing insecurity vis-à-vis India as well as its security relations with the United States. The report noted that the United States could cut off military and economic aid to Pakistan which would harm U.S.-Pakistan relations. It was presumed that Pakistan would be the first country since China to deploy nuclear weapons openly.

Comment: Ultimately, any leverage provided by Pakistani concerns about a cutoff of U.S. assistance proved too limited to influence Pakistan's steady advance to nuclear weapons.

India

The scope of India's future program (and whether India conducts a nuclear test) will be shaped by India's relationship with China. If that relationship continues to deteriorate, it could impel India to acquire nuclear weapons as a deterrent.

Comment: India's 1998 decision to test a nuclear weapon had less to do with China than with pursuit of status and prestige.

South Africa & Israel

The study assess that there exists no security situation that would cause South Africa and Israel to declare their weapons programs.

Comment: As events played out, South Africa did declare its nuclear program in 1991 but only to give it up. Israel has continued not to declare its nuclear capabilities.

Argentina & Brazil

The authors predict that Argentina will not be able to complete its reprocessing plant but will operate its uranium enrichment plant. Nationalism will be the main motivating factor. If a xenophobic regime takes power in Argentina, it could decide to acquire nuclear weapons as a reaction to its political isolation from the rest of the world. Brazil is assessed to be many years away from producing unsafeguarded plutonium.

Comment: The assessment may have underestimated Brazil's parallel nuclear weapons program which was later publicly revealed by new civilian leaders in Brazil.

Iran, Iraq and Libya

The authors state that Iraq and Iran have interests in a nuclear program with safeguards. It would, however, take at least 10 years to develop nuclear facilities that could develop a weapon. Libya's Qaddafi might try to buy or steal weapons but there is a low chance that

he will obtain the needed assistance from the Soviets or Western Europe for a weapons program.

Comment: Though correct for Iran, this estimate may have underestimated the eventual scope and pace of Saddam Hussein's nuclear weapons program. Its emphasis on government assistance to Libya overlooked the wild card of assistance from an individual non-state entity such as would soon be the case with A.Q. Khan's supply activities from the later 1980s onward.

North Korea

The authors judge that North Korea's research reactor will be able to produce significant quantities of plutonium by 1990. They also conclude that North Korea lacks a capability to reprocess the spent fuel from this reactor. The influence of the U.S.S.R. and China on North Korea is seen to be limited.

Comment: This assessment underestimated North Korea's technical capabilities because it succeeded in building a reprocessing plant only some years later.

South Korea

South Korea might build a weapons program in response to North Korean actions. The credibility of U.S. security commitments would be pivotal in persuading South Korea not to do so.

Comment: An accurate assessment, though South Korea has proved more ready not to overreact to North Korea's pursuit of nuclear weapons than anticipated.

Other Major Conclusions and Unique Dimensions

Process of Proliferation – 1960-1980

In contrast to predictions made in the NIE reports, proliferation remained in check from 1960-1980. A number of changes contributed to that outcome, reflecting the fact that proliferation supply and demand, incentives and disincentives have altered.

The NIC memorandum noted that U.S. security alliances and economic incentives have successfully influenced states' nuclear weapons programs. Taiwan and South Korea are both cited as showing the benefits of giving up a nuclear weapons program in exchange for security ties with the U.S.

In turn, nuclear technology export controls and nuclear suppliers' cooperation were seen by the NIC memorandum as having successfully restricted access to sensitive items that could lead to proliferation. This has enhanced disincentives and created delays in proliferation. In particular, transfers of reprocessing or enrichment technology did not occur, forcing states to build their own plants at a higher cost. Most suppliers of nuclear technology voluntarily

put their exports under IAEA safeguards. Still other delays have resulted from the growth of an international norm against proliferation.

With regard to past fears that widespread use of nuclear power would give a growing number of countries access to fissile material, the NIC memorandum noted that economic conditions have slowed the spread of nuclear power to third world countries. Their economies are nearly incapable of providing the large budget demanded by nuclear power programs. The 1980s economic slump in many third world countries also forced many countries to borrow from international financial institutions. These debts were seen to have limited the behavior of third world leaders who want to remain in good standing with nonproliferation regime in order to have access to the international financial system.

In addition, the assessment judged that domestic interest groups are increasingly competing for control of nuclear technology and decision-making. Decisions are no longer in the realm of the privileged few. A social taboo also has emerged against nuclear technology, both for peaceful purposes, as well as for military use.

Future of the Nonproliferation Regime

The assessment forecasts that the international nonproliferation regime can withstand isolated instances of proliferation. This is particularly so if there is ambiguity about the status of a country's activities, as in the case of Israel. The NIC also projects that the nuclear suppliers will continue to cooperate, strengthening their controls on sensitive fuel cycle exports rather than being prepared to provide such exports under IAEA safeguards. Thus, it concludes that the nuclear status quo should not be threatened in the next ten years.

The memorandum also judged that nonproliferation norms would continue to become stronger and nonproliferation standards would become harder to breach. It also envisioned, however, a continuing spread of nuclear-related technology over the period from 1990-1995.

Among possible threats to the nonproliferation regime, the NIC memorandum discussed the spread of technology to states that are not capable of protecting and securing sensitive materials. It also warned of the impacts of a possible decline of U.S. and U.S.S.R. support of nonproliferation efforts. That said, it expected that the United States and the Soviet Union would do everything in their power to prevent their allies from acquiring nuclear weapons.

Assessment

Which aspects of the study have withstood the test of time (i.e. came true)? Which aspects have not?

On balance, the nonproliferation regime did prove very resilient, absorbing Pakistan's acquisition of nuclear weapons as well as North Korea's continuing pursuit of such weapons in the timeframe under discussion. International nonproliferation norms also continued to

become stronger, reflected not least in the moves away from nuclear weapons by Argentina and Brazil as well as by South Africa. Strengthened norms also contributed to the decisions by three former Soviet states – Ukraine, Belarus, and Kazakhstan – to give up former Soviet nuclear weapons stationed on their territories and to become non-nuclear NPT states.

As noted above, however, the NIC memorandum underestimated the technical activities of both North Korea (reprocessing) and Iraq (pursuit by 1990 of a virtual mini-Manhattan Project).

The memorandum also did not foresee the emergence of the A.Q. Khan network, one of the most important proliferation developments in the late 1980s onward.

Did the particular methodology used influence what the study "got right" and what it "got wrong"? How replicable is the methodology? Can it be employed by others?
Looking back at past historical analyses as a step to forecasting the future proliferation environment may have contributed to the memorandum's correct assessment – at least for the time – that the nonproliferation regime was more robust than often assumed. Historical warnings of widespread proliferation had been proved overdone. Similarly, that historical retrospective provided a good vantage point to see how suppliers' cooperation had been institutionalized and norms of nonproliferation developed. That said, the historical analysis of the limits on the spread of nuclear technology which suggested how little had changed since China's bomb – or how slowly capabilities developed – may have partly contributed to the underestimation of the capabilities of North Korea and Iraq.

The method of applying the lessons of historical analysis to understanding a present or emerging situation is quite common. In this case, the lessons learned from the earlier National Intelligence Estimates appear to have improved this analysis. A lessons learned methodology could be replicated as part of other proliferation forecasts.

Was the study influential in some way? If so, how and why? What factors led decision-makers to take notice of it?
The NIC memorandum was an input into ongoing U.S. nonproliferation policy formulation in the 1980s.

Was the study itself influential in changing the course of events, (i.e., did policy intervention result in some aspects of the study being proven wrong)? Or did other external factors change the outcome?

U.S. policy intervention did not result in the NIC's judgments being proved wrong. But external developments both validated some of the memorandum's judgments and disproved others. By way of example, facts on the ground later showed that the NIC had underestimated North Korea's ability to develop a reprocessing capability as well as the extent of Iraq's nuclear weapons activities. Somewhat differently, the strength of

nonproliferation norms was validated by decisions of former Soviet states to give up nuclear weapons.

Missile Proliferation – Survey of Emerging Missile Forces

Washington, D.C.
Congressional Research Service, 1988

Overview
Prepared for the U.S. Congress, this report assesses missile developments in developing countries. It partly entails a technical assessment of the characteristics of missiles and their warheads. The report also includes country case studies that describe missile programs as well as the production and acquisition activities of a set of states. Its purpose was to provide background for Congressional members and their staffs on the growing build-up of missile arsenals in the developing world and provide policy options curb the build up. With some exceptions, its country case studies provided an accurate assessment of broad missile proliferation trends. Some countries, however, proved less capable than anticipated in advancing their missile programs, while others moved somewhat more rapidly than projected.

Date
October 3, 1988; revised February 9, 1989

Commissioned By
Although not stated, the report was probably commissioned by a Congressional committee member staffer. The Congressional Research Services (CRS) works exclusively for the Congress, conducting research, analyzing legislation, and providing information at the request of committees, members, and their staffs. *This was an update of CRS Report 87-654 SPR, "Ballistic Missile Proliferation Potential of Non-Major Military Forces", August 6, 1987.*

Timeframe Examined
Current developments, with some 10-year technical projections.

Prevailing Context
From the early 1980s, there was growing concern about the proliferation of ballistic missiles around the globe. The Missile Technology Control Regime had been formally established in 1987. Within the Congress, Senator Glenn was specifically concerned about Pakistan and its nuclear weapons developments. He was also troubled about missile proliferation in Iraq, Iran, and Saudi Arabia. Starting in the mid-1980s, the Senate had held hearings regarding exports of arms, missiles, and components that could be used for WMD proliferation. China had begun exporting its M-Series missiles to Pakistan and possibly other nations, and the U.S.S.R. was selling a number of shorter range Scud missiles to potentially belligerent nations. The War of the Cities between Iran and Iraq, with each side firing ballistic missiles at the other side's capital, had reached its height in 1988, just prior to Iran's decision to seek a cease-fire with Iraq.

Methodology: Technical Assessment and Country Case Studies
The CRS report focuses on missile technology and the production or foreign acquisition of missiles by countries other than the members of NATO, the Warsaw Pact, and China. The report described at length the technologies behind both ballistic and cruise missile systems as well as current trends in their development. The technical characteristics also are set out of nuclear, chemical, and biological warheads. The report uses open-sources exclusively to support its conclusions. This technical assessment was accompanied by a set of country-by-country descriptions of missile developments of 17 countries in three regions including the Middle East and Africa, Asia, and South America. This part of the report assesses the indigenous production capabilities of nations and reviews the known and probable cases where technical assistance or outright transfers of whole assemblies may have taken place.

Key Projections/Forecasts
As discussed below, the report assesses the capabilities of nations to development missile systems.

Regional Stability Impacts
In its assessment of the military and political significance of missile systems, it is argued that the high speed of ballistic missiles enables an attacker to strike with little warning and makes it very difficult for a defender to destroy incoming missiles. The report projected that as countries acquire more powerful rocket motors, they will be able to deliver larger, more destructive warheads. Some of the countries investigated in this report had or were developing missiles that could carry 1,000 to 2,000 pound warheads.

The report predicted that newly acquired missile systems would sometimes result in regional arms races. Nonetheless, the report judged that the spread of ballistic missiles had not yet made drastic shifts in regional military balances nor significantly affected the vulnerability of some nations to attack. Several factors were seen to explain this limited impact: counters to the systems that had been acquired; the inaccuracy of most systems that have been acquired; and the fact that if ballistic missiles in a regional crisis were believed to carry a WMD warhead, a major world power would intervene.

Assessment

Which aspects of the study stood the test of time (i.e. came true)? Which aspects have not?
With some exceptions, the study provided an accurate description of missile programs and activities around the globe. For instance:

Brazil
The study assessed that short-range systems were probably in an advanced stage of development but had not been put into production. The development and testing of longer-

range missiles was thought probably constrained by the lack of key foreign-made components and perhaps by insufficient testing of short-range systems on which bigger missiles will be based.

Comment: Brazil conducted research on short and longer range rockets as a part of its space launch program. It also attempted to build its own space launch vehicles and lessons, providing it with experience could be used in developing a long-range missile.

It also was assessed that Brazil could construct an atomic bomb with a crash program in five years (from the 1988 publication date of the report).

Comment: Brazil's leadership decided instead to shelve its parallel nuclear program and not to seek a nuclear weapon capability.

India

The study assessed that India's Agni missile had two stages with a liquid fueled first stage and solid fueled second stage. This would provide it a range of 1,500 miles.

Comment: First tested in 1992, the Agni missile was developed by stacking the shorter range liquid fueled Prithvi on top of a solid rocket booster thought to have come from India's developing space launch vehicles (SLV-3). Since then, India has developed variances on the Agni to extend its range and payload capability.

Iran

The study identified China as the largest supplier of military equipment to Iran with over 600 million dollars in sales. It posited that China may have provided its own version of the Scud-B missiles to Iran and that North Korea may have been transferring missiles to Iran.

Comment: In fact, since the 1980s, Iran has focused its missile cooperation on relationships with China, Russia, and North Korea.

Iraq

The study assessed that while Iraq had a growing research and development program, there was little reason to believe that it would have the indigenous capability to produce key components such as guidance systems, reentry vehicles, or nuclear missile warheads in the near future.

Comment: When United Nations Special Commission (UNSCOM) inspectors visited missile and other facilities in Iraq after the first Gulf War, they were surprised at how far along the Iraqis had been able to proceed in developing missiles. They noted that Iraq had sophisticated equipment and designs that were imported from various Western countries.

Pakistan
The report assessed that there is mounting evidence that Pakistan will possess nuclear weapons shortly (in 1988-1989).

Comment: Open sources suggest that Pakistan probably achieved its nuclear capability in the late 1980s into the early 1990s, as indicated by the inability of President George H. Bush to certify that Pakistan did not possess a nuclear device (as required by Congressional legislation).

North Korea
The study judged that North Korea did not possess nuclear weapons and that without external assistance it would be unable to produce a nuclear warhead suitable for a missile by the turn of the century.

Comment: Although there was much speculation regarding the amount of plutonium available to North Korea to produce a nuclear weapon, North Korea did not test a device until 2006. It remains to be seen if the North has been able to miniaturize and adapt a device into a warhead to be delivered on a missile.

South Korea
The study noted that South Korea had announced that it intended to test-fire a space launch vehicle in 1991 and to launch a 1,000-pound satellite into orbit by 1996. By the year 2001, its goal was to build a sophisticated space launcher and telecommunication satellites. If South Korea achieves these goals, it would probably be able to produce long-range ballistic missiles as well.

Comment: South Korea has yet to build and/or launch a space launch vehicle. Under its revised plans to launch a vehicle by the end of 2007 or early 2008, South Korea has been working with Russian companies to construct a launch platform.

Did the particular methodology used influence what the study "got right" and what it "got wrong"? How replicable is the methodology? Can it be employed by others?
The authors used a straight forward technical reporting methodology for assessing the missile developments of the target nations. The report is focused mainly on indigenous production capabilities and foreign assistance. This methodology is standard for this type of reporting. The report does not consider the geopolitical interplay (both internal and external) that both motivates and constrains a country in developing missiles.

Was the study influential in some way? If so, how and why? What factors led decision makers to take notice of it?

The report probably provided useful background to Congressional staffs in addressing missile proliferation issues. More direct impacts are unknown.

Was the study itself influential in changing the course of events, (i.e., did policy intervention result in some aspects of the study being proven wrong)? Or did other external factors change the outcome?

Policy efforts to slow the spread of ballistic missiles proved at best partly successful. The Argentine Condor program was shut down, for example, but China continued supplying Pakistan and Iran with missiles. North Korea also emerged as a major missile supplier, accelerating missile proliferation.

Nuclear Proliferation in the 1990s: The Storm After the Lull

Leonard Spector
In New Threats: Responding to the Proliferation of Nuclear, Chemical, and Delivery Capabilities in the Third World
Aspen Strategy Group Report, 1990

Overview

Using a country case study methodology, this assessment depicted an expanding nuclear threat stemming from threshold states' movement to acquire nuclear weapons and efforts by emerging nuclear states to improve the technical sophistication of their nuclear postures in the 1990s. The assessment also expressed concern that the continuing gap between the nuclear weapon states and the non-nuclear weapon states in the Treaty on the Nonproliferation of Nuclear Weapons (NPT) would lead to an erosion of support for that treaty. Particular attention was focused on Pakistan's acquisition of an untested nuclear device as well as on North Korea's pursuit of nuclear weapons and the perceived pressure that this action could be putting on South Korea to follow suit. The emergence of second-tier suppliers was also flagged as a cause of concern, and the important role of domestic political developments in Argentina and Brazil was noted. Ultimately, several of the study's assessments were undercut by unexpected domestic political wild cards, including the collapse of the Soviet Union (affecting the dynamics of the North Korean nuclear program) and the decision of the South African government to transfer power and give up nuclear weapons. The case study methodology, with its reliance on available information and with the depth of the case studies tied to the knowledge of the single author was not attuned to such factors. (By contrast, an alternative futures sensitivity analysis tied to each case study might have flagged such wild cards.)

Commissioned By

This assessment was presented at the August 1989 meeting of the Aspen Strategy Group, and subsequently published in the Aspen Strategy Group Report.

Purpose and Objectives

This estimate seeks to explain what proliferation trends and events will occur in the 1990s, based on long-term assessments of individual states in possession of nuclear capabilities.

Timeframe Examined

The historical timeframe examined covers the decade of the 1980s, with projections extending through the 1990s.

Prevailing Context

Written in 1989, the prevailing historical context was the start of the end of the Cold War. The Soviet Union had not yet collapsed nor had the Berlin Wall come down but Premier

Gorbachev had brought about major changes in Soviet life with *Perestroika* and *Glasnost*. The U.S.-Soviet arms control process had led to the 1986 Stockholm Agreement and the 1987 Intermediate and Shorter-Range Nuclear Forces Treaty. In Asia, the Soviet Union had withdrawn its troops from Afghanistan. In terms of nonproliferation, there was continuing concern about Pakistan's pursuit of nuclear weapons, but neither India nor Pakistan had yet to become open nuclear weapon states. Israel's nuclear technician, Mordechai Vanunu, had confirmed the existence of Israel's nuclear arsenal. There had been significant use of chemical weapons by Iraq against Iran in the Iran-Iraq War, though that war had recently ended. In South America, Argentina and Brazil were emerging from their military regimes of the 1980s, while taking cautious steps towards nuclear rapprochement. The white regime in South Africa, however, had yet to take steps to turn over power to the black majority nor to acknowledge and then give up its nuclear arsenal.

Methodology: Country Case Studies

The study focused on a list of countries of proliferation concern on a case-by-case basis, taking into account the domestic and regional motivations for acquiring nuclear weapons as well as the technological capabilities of each state. In so doing, it addressed each state's particular context and perception of how and why it should or should not go nuclear. The impacts of elections, security concerns, threat perceptions, and international diplomatic pressure were also considered.

Key Projections/Forecasts

Horizontal Proliferation

The author estimated that Pakistan had acquired an untested nuclear capability in response to India's nuclear capability and its superior conventional capacity. He also estimated that both countries would apply technological advances as quickly as possible, increasing the reach of ballistic missiles and the yield of the nuclear weapons they would seek to develop. If North Korea should acquire nuclear weapons, then South Korea might also follow suit. The study postulated that the end of the Iran/Iraq war meant that those countries could now devote their resources to nuclear development, but that these efforts would not bear fruit for at least ten years (until 1999). He argued that whether or not Argentina and Brazil continued to move toward a nuclear rapprochement in the region would be principally based on the success of the civilian governments and economic recovery. Policies in both countries would also be strongly influenced by popular opinion, which at the time was decidedly anti-nuclear. In turn, the author noted that the lines between nuclear and advanced conventional weapons were being blurred through technological advances and horizontal proliferation of the latter. This could ultimately lead to a weakening in the norm against acquisition of nuclear weapons as well.

Proliferation Dynamics

The estimate argued that the decision to go nuclear would depend on the individual state, the regional balance of power, domestic political factors, and technological capability. It was

concluded that diplomatic pressure *may* convince a state to delay its nuclear progress, as in the case of Pakistan, South Africa, Brazil, and Argentina.

Vertical Proliferation

The assessment was pessimistic regarding several nonproliferation related treaties. The Treaty on the Nonproliferation of Nuclear Weapons (NPT) was viewed as being in danger of complete dissolution, given the belief of the Non-Aligned Movement (NAM) that the United States and the Soviet Union had failed to comply with their Article VI obligations and to work towards disarmament. In his estimate, the author hypothesized that the NAM might use this leverage to force the nuclear weapons states (NWS) to trade significant progress toward nuclear disarmament for an indefinite extension of the treaty in 1995 (when the issue of NPT extension would come up by the treaty's terms.) Moreover, the ongoing negotiations of the Chemical Weapons Convention – which would ban an entire class of weapons for *all* states – was seen as highlighting the perceived unfairness of the NPT's two-tiered system of nuclear haves and have nots.

Regions/countries of greatest concern

Although the study assessed the nuclear capabilities of eleven states, Pakistan and North Korea were seen as the two countries of greatest concern. Pakistan was considered to be an untrustworthy ally of the United States and involved in black market trade in nuclear and weapons-related materials. It had the potential to be a "second-tier" supplier of unsafeguarded materials. North Korea was a concern because it was a staunch communist ally of the Soviet Union, which was at the time considered a threat to the United States. North Korea's proximity to U.S. troops in South Korea and allies such as Japan reinforced this assessment. Moreover, the assessment concluded that should North Korea gain nuclear weapons, South Korea and Taiwan could be provoked to respond in kind to the new security situation.

Acquisition patterns/trends

Potential proliferant states were seen as seeking to acquire an unsafeguarded enrichment capability. It was noted that even if safeguards were applied, such as in Iraq and Iran, the stockpiling of weapons-grade uranium and plutonium would still not be illegal, as long as it was accounted for and not used for weapons purposes. Thus, states were able to engage in a practice of nuclear hedging, while at the same time clandestinely acquiring weapons components for future assembly.

In addition, a nuclear black market was also seen to be emerging. This trend was evidenced by Pakistan's acquisition of nuclear equipment and raw materials from West Germany as well as Brazil's and Argentina's avoidance of safeguards and use of clandestine purchasing operations in the growth of their nuclear programs. This black market availability could lead to the emergence of a group of second-tier supplier states, willing to sell unsafeguarded materials to potential proliferant states.

As noted, those states with an existing nuclear weapon capability were seen to be working to improve those capabilities. For example, India and Israel were developing longer-range ballistic missile systems and, it was suggested, likely seeking to increase the explosive yield of their nuclear weapons, through "boosting" or gaining thermonuclear technology. These states were seeking to acquire radioactive substances such as lithium deuteride (Israel and India), tritium (India and Pakistan), and lithium (India and Pakistan).

The assessment argued that all of the existing proliferators had managed to acquire the majority of their stockpiles of nuclear weapons materials in the 1980s. This implied that a state may hold on to its stockpiled materials for approximately ten years before actually developing weapons.

Deterrence and employment concepts

Deterrence was discussed primarily as it applies to Israel's capabilities. Given the author's estimate that Israel possessed between sixty to one hundred nuclear devices, the study concludes that this would ensure Israel sufficient deterrent power to guarantee its survival as a state. Furthermore, Israel's development of longer-range ballistic missiles served as a deterrent against Soviet intervention in the Middle East, particularly in support of Syria.

In terms of the Middle Eastern regional balance of power, Israel's nuclear weapons capabilities were seen to deter other nations in the region from using chemical weapons and missiles against Israel. However, the assessment noted that this relationship could also work in reverse – with the missiles and chemical weapons of Syria, Iraq, Iran, and Egypt preventing Israel from attacking. If deterrence were to fail in the Middle East, it is possible that the threshold for nuclear weapons use could be breached, even absent the threat of Israel's national annihilation.

The author argued that the India-China relationship was not based on deterrence. Despite China's nuclear capabilities, India had not pushed ahead to deploy nuclear weapons, even if they had developed a nuclear weapon capability. Had India's leaders thought India threatened by China, the assessment argued, India would have gone a step further and deployed and/or tested nuclear weapons.

Other Major Conclusions and Unique Dimensions

Overall, the nuclear nonproliferation regime was seen as returning to a 1970s period of uneasiness, with several states on the threshold of possessing nuclear weapons and others seeking to improve their already existing nuclear capabilities. Bilateral and multilateral pressure could yet stem this trend, especially in the case of Pakistan, South Africa, Argentina, and Brazil. North Korea would be most susceptible to pressures from the Soviet Union.

Assessment

Which aspects of the study have withstood the test of time (i.e., came true)? Which aspects have not?

This assessment entailed case studies of eleven states. The actual outcome of events for each state varied:

North Korea and South Korea

North Korea did continue to resist IAEA safeguards, withdraw from the NPT, and eventually explode a nuclear device in 2006. Expectations that Soviet pressures could prevent this outcome were proved wrong – possibly due to the collapse of the Soviet Union in 1991 and the internal chaos that followed. As in other instances, a wild card event appears to have had a major impact. However, the political and security repercussions of North Korea's advance toward the bomb were not nearly as negative as expected. South Korea has not responded in kind to the North's pursuit of acquisition of nuclear weapons; it has even taken steps to improve its relationship with North Korea.

Iran

Iran has proved to be more of a problem than anticipated by the author. At the time, information was not available about Iran's mid-1980s decision to launch a clandestine uranium enrichment program. While noting the possibility of second-tier supplier states, the assessment missed the emergence of the A.Q. Khan as a "one-man" nuclear weapon entrepreneur, with that development's contribution to Iran's uranium enrichment activities.

Libya

Libya was seen to be in a "dormant" state, but as was revealed by Colonel Qaddaffi after his 2003 promise of full disclosure of Libya's proliferation activities, Libya at that time actually *was* pursuing nuclear, chemical, and biological weapons programs.

South Africa

The estimate failed to predict the decision of South Africa's white leadership to transfer power to the black majority as well as then to give up its nuclear weapons in 1993 and join the NPT. Again, a domestic wild card had a decisive proliferation impact. But that development was virtually unpredictable at the time of the estimate.

Effects on the Nonproliferation Regime

The estimate expressed concern that the Nonproliferation Regime was in peril due to a perceived lack of progress on implementing Article VI of the NPT. As it turned out, the 1995 Review and Extension Conference managed to achieve a grand bargain and extend the NPT indefinitely.

Did the particular methodology used influence what the study "got right" and what it "got wrong"? How replicable is the methodology? Can it be employed by others?
The author's case study methodology – drawing on existing open source materials – resulted in a careful assessment of the state of play in each country. However, given that one author carried out the analysis, the results were inevitably more thorough for some states and regions than others. Constraints on information also shape the depth of the analysis for any given country. As a result, in the assessment, Iran and Libya were somewhat under-analyzed, whereas the North Korea and Israel assessments were very thorough. The case study methodology did not focus on the types of wild card events that proved so important in shaping some of the outcomes.

Was the study influential in some way? If so, how and why? What factors led decision-makers to take notice of it?
Presented at the Aspen Strategy Group meeting in August of 1989, the study likely contributed to the thinking of prominent analysts and policy makers, many of whom subsequently went on to even more powerful positions in government. The organization of the estimate was easily accessible, with analysis divided up according to capabilities and states, offering a clear look at which states presented what type of threat or potential threat.

Was the study itself influential in changing the course of events, (i.e., did policy intervention result in some aspects of the study being proven wrong)? Or did other external factors change the outcome?
Unanticipated changes in the 1990s dramatically impacted proliferation trends during that decade. The collapse of the Soviet Union led to Russia playing little role in stemming the proliferation threat from North Korea. Rather, the loss of an external ally and source of economic support may have reinforced North Korea's pursuit of its nuclear weapons program. Somewhat differently, the wild card of South Africa's regime change dramatically affected the proliferation situation as to a lesser degree (and in the opposite direction) did the rise to power in 1998 of the BJP Party in India.

More broadly, the estimate reflected a continuing tendency to stress that the NPT is in crisis due to the differences over Article VI. This may eventually prove correct. But at least as of the time of the study, criticism of the NPT continued not to lead to action against the treaty by the NAM movement.

Section III: Historical Sources

"1970 Without Arms Control." In *Special Project Committee on Security Through Arms Control*. Washington, D.C.: National Planning Association, 1958.

"Development of Nuclear Capabilities by Fourth Countries: Likelihood and Consequences." In *National Intelligence Estimate*. Washington, D.C.: National Intelligence Council, 1958.

Dunn, Lewis A., and Herman Kahn. "Trends in Nuclear Proliferation, 1975-1995. Projections, Problems, and Policy Options." edited by Hudson Inst: U.S. Arms Control and Disarmament Agency 1976.

"The Dynamics of Nuclear Proliferation: Balance of Incentives and Constraints." In *Memorandum 85-10001*: National Intelligence Council, 1985.

Lawrence, Robert M., and Joel Larus, eds. *Nuclear Proliferation Phase II*, National Security Education Program: University Press of Kansas, 1974.

"Likelihood and Consequences of Proliferation of Nuclear Weapons Systems." In *National Intelligence Estimate*. Washington, D.C.: National Intelligence Council, 1963.

McNamara, Robert. "Memorandum for the President: The Diffusion of Nuclear Weapons With and Without a Test Ban Agreement." Washington, D.C., 1963.

Meyer, Stephen M. *The Dynamics of Nuclear Proliferation*: University of Chicago Press, 1984.

"Missile Proliferation - Survey of Emerging Missile Forces." Washington, D.C.: Congressional Research Service, 1988.

"Nuclear Weapons Production in Fourth Countries: Likelihood and Consequences." In *National Intelligence Estimate*. Washington, D.C.: National Intelligence Council, 1957.

Pipes, Richard. "Intelligence Community Experiment in Competitive Analysis: Soviet Strategic Objectives – an Alternative View." In *Report of Team B*, 1976.

"Report to the President by the Committee on Nuclear Proliferation ", edited by Gilpatric Committee. Washington, D.C.: The White House, 1965.

"Soviet Forces for Intercontinental Attack Through the Mid-1980s (Volume 1 of 3)." In *National Intelligence Estimate*. Washington, D.C.: National Intelligence Council, 1975.

Spector, Leonard. "Appendix A: Nuclear Proliferation in the 1990s: The Storm after the Lull." In *New Threats: Responding to the Proliferation of Nuclear, Chemical, and Delivery Capabilities in the Third World*: Aspen Strategy Group Report, 1990.

Wohlstetter, Albert, and Henry Rowen, eds. *Swords from Plowshares – the Military Potential of Civilian Nuclear Energy*. Chicago: University of Chicago Press, 1979.

Section IV: Contemporary Assessments
Synthesis Paper

Contemporary WMD Forecasting: Themes, Projections, and Findings

Introduction

This section of the report provides an analytical survey of twenty-three contemporary WMD forecasting studies conducted since 1997. It identifies general features of the WMD forecast studies reviewed, overarching themes, consensus propositions, areas of disagreement, wild cards, and methodology. The study also discusses how WMD forecasting has changed since the terrorist attacks of September 11, 2001.

General Features of the WMD Forecast Studies Reviewed

Subject Matter

The list of 23 contemporary studies assessed appears below in Table 1. Of these studies, six focus primarily on nuclear issues, six on biological, and three on missile systems. The remaining eight studies address a composite array of WMD, usually covering nuclear, chemical, and biological weapons, and missile delivery systems as distinct elements of a the overall WMD threat. Some of the studies touch on radiological weapons, but none focus on radiological dispersal devices (RDD) to a significant degree. The sample as a whole addresses the range of NBC and missile delivery systems.

Date

Four of the assessed studies appeared after 1997 but before 9/11. One, a declassified National Intelligence Estimate (NIE) on the ballistic missile threat was published in December 2001. However, most of its objectives and preparation predated 9/11. The remaining eighteen studies appeared post-9/11. Not surprisingly, these studies featured non-state actor WMD threats more prominently than earlier WMD forecast studies typically had done.

Scope and Methodology

The contemporary WMD studies in the sample are rather diverse in their scope and methodological approaches. Generally, they all aim to foresee potential WMD development or proliferation. However, most of their forecasts extend only a decade into the future and lack specificity. They vary widely in the extent to which they attempt to forecast one or another form of WMD proliferation by specific regions and actors, and types of prospective WMD use. Few carry their projections beyond the hypothetical into the realm of concrete political-military or operational WMD threats. Those that do – and these typically are intelligence assessments in our sample -- rarely venture to pinpoint expected developments

in WMD weaponization and military delivery capability in a precisely defined span of time. Most of the sampled studies fall into one of the following categories:

- **Nuclear and/or missile proliferation:** political-military and technical assessments of the status, rate, locations and possible future forms and patterns of nuclear weapons proliferation and long-distance means of delivery.

- **Biological weapons development:** science-based studies of potential bio-engineering of existing pathogens and creation of novel pathogens, and foreseeable methods of delivery, that pose unique challenges to detection and effective response.

- **Physical WMD technologies:** technology-based studies that seek to ascertain how technology evolution or breakthroughs might support previously unforeseen types of WMD and strategic delivery, and thereby stress U.S. defense or contemporary deterrence, and how appropriate R&D may counter or neutralize those threats.

- **Alternative futures, conjectures, and scenario analyses** that attempt to identify what kinds of WMD threats might plausibly be mounted operationally against US interests by certain types of state and non-state actors, and what countermeasures those threats would call for.

- **Geopolitical trend analysis:** traditional geopolitical analysis and forecasts of trends among adversaries and their prospective acquisition or development of WMD capabilities that could harm the U.S. or challenge its interests overseas.

- **Quantitative proliferation analysis:** quantitative analysis of country data-sets with variables that purport to explain whether and when, or under what ascertainable conditions, states attempted to acquire or, alternatively, shifted away from possessing nuclear WMD in the past, and that might operate similarly in the future.

- The **Lugar Survey on Proliferation Threat and Response** is one of a kind and does not fit into any of these categories neatly. Rather, it polls national security experts on what they estimate to be the probability of certain kinds of WMD attack in future time spans and publishes tabulations of their responses.

Table 1. Assessed Contemporary WMD Forecast Studies				
Date Range	No.	Title	Source Type	Modal WMD Type
1997-2000	1	Tracking Nuclear Proliferation 1998, June 1998	Carnegie (NGO)	Nuclear
	2	*Commission to Assess the Ballistic Missile Threat (Rumsfeld),* July 1998	USG Commission	Missile
	3	*Living Nightmares: Biological Threats,* 1999	Jasons	Biological
2001-2003	4	Global Threats and Challenges Through 2015, March 2001	DIA to SASC	Composite WMD
	5	Foreign Missile Developments and Ballistic Missile Threat To 2015, Dec. 2001	CIA: Declass NIE	Missile
		Gathering Biological Storm (GBS), April 2002	USAF Counter-Prolifer. Center	
	6	*GBS - Prospects of Biological War in Middle East*	" "	Biological
	7	*GBS - Assessment of the Emerging Biocruise Threat*	" "	Biological
	8	*GBS - Next Generation Bioweapons and Biological Warfare*	" "	Biological
	9	*GBS - Biological Warfare Wake-Up Call: Prevalent Myths and Likely Scenarios*	" "	Biological
	10	*Biotechnology: Impact on Biological Warfare and Biodefense,* 2003	Individual	Biological
2004-2007	11	*Role of Nuclear Weapons: Alternative Futures for the Next Decade,* May 2004	CIA - NIC	Nuclear
	12	*Nuclear Tipping Point – Why States Reconsider Nuclear Choices,* 2004	CSIS and William & Mary (NGO)	Nuclear
	13	*Correlates of Nuclear Proliferation,* Dec 2004	Individual	Nuclear
	14	*Mapping Global Future - Report of NIC's 2020 Project,* Dec 2004	CIA - NIC	Composite WMD
	15	*Deadly Arsenals: Nuclear, Biological and Chemical Threats,* 2005	Carnegie (NGO)	Composite WMD
	16	*Lugar Survey on Proliferation Threat and Response,* June 2005	US Senator	Composite WMD
	17	*Changing Face of Proliferation: Thoughts, Speculations, and Provocations,* Feb. 2005	CSIS (NGO) and Sandia (USG)	Composite WMD
	18	*Thwarting an "Evil Genius,"* Aug 2006	SAIC (NGO)	Composite WMD
	19	*What Missile Proliferation Means for Europe,* 2006.	Individual	Missile
	20	*Nuclear Weapons Proliferation: 2016,* November 2006.	Naval Post-graduate School	Nuclear
	21	*Current and Projected National Security Threats to the United States,* January 2007	DIA	Composite WMD
	22	*Determinants of Nuclear Weapons Proliferation,* February 2007.	Individual	Nuclear
	23	*Air Force Futures Project: Emerging WMD Technologies,* 2007	USAF	Composite WMD

9-11

Sponsor

A quick scan of Table 1 also reflects the diversity of these studies in terms of sponsorship and initiative. More than half of the studies have U.S. government sponsorship of some kind. The representation of intelligence and defense agencies is in keeping with the fact that forecasting is a core part of their organizational mission. Of the remainder, roughly half are NGO think-tank studies or studies by individuals, including academic scholars.

As a side note, the sample of studies is statistically skewed towards USG and DOD sources because the study team decided to include four chapters of a single volume – *The Gathering Biological Storm,* prepared by the USAF Counterproliferation Center – as individual assessments, rather than as parts of a single composite assessment. The distinctive substantive focus of each of the four chapters – united though they are under the biological weapons theme – made it appropriate that they be assessed separately.

Overarching Themes

Several overarching themes ran through most of the contemporary studies. None of the overarching themes provide benchmarks, however, for precise forecasts of the locations, timeframes or specific types of WMD acquisition and the distribution among states and non-state entities in the future.

- Any major future conflict is most likely to occur in Asia. However, the likelihood of large conflict is low. Limited local and internal conflicts are likely to be commonplace, however, in the Middle East, Africa, and even in parts of Latin America.
- The international diffusion of scientific knowledge and weapons-related technology is accelerated by the forces of globalization and international trade. Accordingly, the know-how to develop WMD will be more widespread and easier to access.
- Globalization and international trade are also expanding forms of transnational economic and political activity. Such activities are not easily monitored or controlled by states, even when the activities pose a threat to public health or law and order.
- Globalization enables the transnational networking of illicit organizations, terrorists, criminal enterprises, clandestine state procurement networks, and black markets – where conventional arms and WMD materials are prone to circulate.
- While the barriers to independent development of nuclear technology and long-range missile delivery capabilities remain significant, a large number of states have the means to pursue these capabilities. At some point, a wave of nuclear proliferation among states with latent capabilities could occur, changing the threat environment systemically.
- In the chemical and biological weapon fields, the technical, financial, and regulatory barriers to proliferation are lower than with nuclear technology. Therefore, an increase in covert state military development of CW and BW can be expected.
- As advanced scientific knowledge spreads among nation states, the development of more potent classical pathogens and new classes of pathogens and biological agents is virtually inevitable – presenting threats of catastrophic, and perhaps apocalyptic, magnitude.

- As WMD capabilities proliferate and become more widely available, these weapons are likely to pass into the hands of non-state actors, especially terrorist organizations but also criminal networks. These weapons will be used to cause mass destruction or disruption in ways that are hard to prevent and almost impossible to deter.
- International controls probably help slow the rate and volume of WMD proliferation. However, they are incapable of arresting it entirely.
- The United States is far less well prepared to meet these future challenges than it could be. Specifically, the U.S. must develop better intelligence, support more focused research on evolving capabilities, sponsor the research and development needed for countermeasures, and invest in countervailing capabilities.

Consensus Propositions

The comparative analysis of the assessed studies reveals a number of concrete points of agreement about future WMD proliferation. Put together, these points can be condensed in a series of 27 propositions that reflect a measure of consensus among sources in the sample. The propositions can be divided into three broad categories: (1) consensus concerning potential *threats* from WMD proliferation; (2) consensus concerning *military technology* associated with WMD proliferation; and (3) consensus concerning *opposing strategies* likely to be favored by WMD proliferators.

WMD Threats

1. Nuclear weapons will remain the gold standard for most future WMD proliferation.

Among the WMD options available to proliferating states, the assessed studies evinced a high level of agreement on the proposition that nuclear weapons will remain the gold standard for most dedicated proliferator states and hedging states as a perceived way to level the military playing field against the military power of advanced countries or the emerging nuclear capabilities of rival states. Most studies also agreed that poorer or developing countries that could not easily obtain nuclear technology but desired to develop WMD capabilities probably would attempt to develop CW or BW options as cheaper alternatives first, and might not get past that point. Studies that emphasized the BW potential of the biological sciences also suggested that advanced countries would have to explore this field to understand and prepare for future BW threats, at least for defensive purposes. But there were no studies that suggested that states capable of pursuing nuclear weapons would view CW or BW as long-term substitutes or preferred alternatives. The assessed studies acknowledged that terrorist organizations probably would find access to CW or BW much easier than to full-fledged nuclear weapons but could still attempt to exploit purchased or stolen nuclear material and radiological dispersal devices, and that some terrorist organizations would pursue these options.

2. WMD use is more likely in the foreseeable future than it was during the Cold War.

Many of the studies agreed that the likelihood of some WMD use, either as a direct attack on the United States or its allies' homeland, or against forward deployed U.S. and allied forces or facilities in a regional conflict, is higher now and will remain so in the foreseeable future than it was during the Cold War. This was a relative judgment that seemed to reflect agreement that nuclear deterrence was effective during the Cold War against any adversary attacking the West in an overt military operation with nuclear weapons (or CW/BW for that matter), but that Cold War deterrence could not be counted on against future rogue state or terror threats. At the same time, while the studies tended to agree such an attack could occur at any time, they provided no forecasts of particular adversaries mounting such an attack, which form of WMD would be used, or a specific timeframe for such an attack.

Senator Lugar's *Survey on Proliferation Threats and Responses,* which polled national security experts, was indicative of their expectations of some form of attack: some 60% of respondents, for example, judged that there was a 10% probability that the world would see a nuclear attack somewhere within 5 years, and a 20% probability of a nuclear attack somewhere within 10 years. About 79% of the respondents also judged that if a nuclear attack occurs within the next 10 years, it would more likely be an attack by a terrorist organization than a state.[1] In the studies overall, however, other scenarios also thought likely to result in WMD use were posited in the military context, e.g., a state uses WMD to attack the U.S. or allies in a regional conflict overseas, where U.S. or allied forces were preparing to intervene or had intervened in the conflict.

3. Nuclear proliferation by states will continue gradually, as in the past – unless a "tipping point" is reached.

A prominent theme in the nuclear proliferation-focused studies was the possibility that runaway nuclear proliferation could ensue at some point, after a tipping point has been reached, probably due to a chain of security shocks in the international system. Some of the studies emphasized, however, how gradual actual nuclear proliferation has been globally over the last five decades, and how important key reversals have been – notably, in Taiwan, South Korea, Argentina, Brazil, South Africa, former Soviet republics such as Ukraine and, recently, Libya – in keeping the number of states that are recognized as nuclear powers or believed to have secret programs far smaller in number than earlier forecasts in the 1950s and 1960s (or even some more recent assessments) had projected.

[1] In the Lugar survey, the suggested probability among experts for CW, BW, and RDD attacks in the next 5 and 10 years was higher than for nuclear. On the risk of an actual biological attack, the estimate was a 10-20% likelihood in 5 years, and a 20% probability in 10 years. For an actual chemical attack, the estimate ranged from 10-30% likelihood in 5 years, and a 20% likelihood in 10 years. For a radiological attack, the risk was seen as a 25% likelihood in 5 years, and 40% likelihood in 10 years.

4. The increasing pace of technology innovation, globalization of commerce, and the formation of black markets will ease access to dual-use technologies and relevant nuclear proliferation materials, widening latent as well as overt nuclear proliferation.

While the nuclear proliferation studies tended to focus on the relatively small number of current states of concern, there was a high level of agreement that nuclear proliferation as a process is unlikely to be arrested and will continue inexorably. Many studies saw technology diffusion and the globalization of commerce as ineluctable forces that contribute to the spread of nuclear (and other WMD) capabilities. Those that were published after the disclosure of the A. Q. Khan's nuclear network also emphasized the role that black markets can be expected to play in future nuclear (and other WMD) proliferation.

5. A "tipping point" of nuclear proliferation by state actors between 2005 and 2025 (or beyond) could quadruple or quintuple the number of emerging nuclear powers in the Middle East and Northeast Asia.

Events demonstrating Iranian and North Korean success in developing nuclear weapons and long-range missile systems, or an actual use of nuclear weapons in conflict, are cited as examples of what could trigger an "explosive burst" of proliferation. These events could convince a large number of other nations, particularly among neighbors in the Middle East and in East Asia, to conclude that the nonproliferation regime had failed and starting a nuclear weapons development program, or at least a hedge against a worsening security environment, was imperative. Countries that are compliant with the NPT today but considered possible candidates for reversing course if a tipping point is reached include Japan, Taiwan, South Korea, Turkey, Saudi Arabia, Egypt, Syria, Algeria, Ukraine, Serbia, Greece, Brazil, Argentina and Venezuela.

6. Chemical weapon proliferation among state actors can be expected to continue in the Middle East and North Africa as the "poor man's" entry point to WMD through 2015 and beyond, but as Western defenses against CW improve, state CW use is more likely against regional states than advanced countries.

Following the pointers in unclassified intelligence reports, many studies already attribute past or existing CW programs to such countries as Russia, China, North Korea, Iraq (before 2003), Iran, Israel, Syria, Egypt, Libya (until 2004), Sudan, India, and Pakistan. The assessed studies share a measure of consensus that most if not all of these countries probably would retain their infrastructure capabilities (even if some of them have given up or no longer maintain stockpiles of CW agent) as a deterrent hedge, as a baseline for development of "defensive" equipment and countermeasures, or to jump-start modern an offensive programs in the event their security environment worsens. Underlying concerns expressed in many of the studies are that some of these states with CW capabilities might assist other states in acquiring CW capabilities as their entry-level WMD program, and that one or another state may be tempted to provide sponsored terrorists access to CW agents.

A theme in the assessed studies – more as a question mark than a forecast – was whether the slowly improving U.S. and Western defensive capability against CW would lead CW-capable countries to reduce their emphasis on this form of WMD. A related thought expressed in Lewis Dunn's "Changing Face of Proliferation" paper was that this improving defensive capability against CW could lead military planners in adversary countries to set CW aside in confronting the outside powers but would not necessarily lead them to set CW aside in conflicts with regional neighbors.

Not in outright disagreement with the consensus proposition but as a difference of emphasis, the Carnegie Endowment *Deadly Arsenals* book draws sharp distinctions between the different types of WMD. It considers CW to be a serious but much less consequential WMD threat than nuclear or biological weapons and ascribes a higher level of arms control compliance to the elimination of declared CW programs and arsenals under the Chemical Weapons Convention, which by implication would forecast a lesser CW threat from states than the consensus view would suggest.

7. As knowledge of the biological sciences and genetic engineering diffuses, the spread of biological weapon capabilities among state actors can be expected to expand in advanced and developing states.

This science and technology-driven proposition was advanced by the science-based BW studies and generally shared by the composite WMD studies. It rests on the assumption that the database of DNA and genomic analysis, the power of computers, and availability of inexpensive laboratory equipment for biological engineering will become pervasive around the world, readily accessible to biological scientists even in developing countries. It further assumes that while biological advances will be exploited for constructive social and economic objectives, some scientists recruited and funded, or self-selected, to do weapon research in every substantial country will explore all imaginable avenues of biological engineering, learning how to modify classical bacterial and viral pathogens, how to devise new agents, and how to exploit the pathways of human physiology to spread old and new diseases in methodical ways that will be hard to detect, will surprise, and will be designed to thwart effective treatment and countermeasures. The studies assume that relatively advanced countries and past adversaries, such as Russia and China, will build on past BW programs to discover new ways to wage biological warfare, and file them away for undefined future contingencies, and that the same knowledge and technology will be acquired by developing countries and perhaps even by terrorist and criminal organizations.

8. It is only a matter of time before al-Qaeda, one of its affiliates, or some other terrorist organization, gains access to one or more usable NBC capabilities and uses them to threaten and/or attack U.S. or Western interests or territory.

All of the composite WMD studies published since 9/11 and the discovery by U.S. forces in Afghanistan in December 2001 of documentary evidence of dedicated al-Qaeda research and experiments on rudimentary CW and BW, together with intelligence on al-Qaeda efforts to obtain fission weapons and fissile material from post-Soviet sources, reflect this proposition

that it is only a matter of time before al-Qaeda or one of its stateless affiliates acquires and uses some form of WMD in what could be a spectacular attack. No time-bound forecasts of this eventuality are represented, but neither did any of the studies dissent from this consensus expectation. Rather, it was assumed that a WMD terrorist attack could be so targeted and implemented as to take us by surprise, like the attacks of 9/11, and could occur at almost any time. As reflected in the January 2007 DIA statement, "Current and Projected National Security Threats," the pursuit of the al-Qaeda network globally, in Iraq since 2004, and within the Afghan borderland with Pakistan, coupled with a full court press on communications surveillance, more detailed monitoring of air passengers and traffic, and tightened border controls presumably makes terrorist preparation and implementation of a spectacular attack more difficult than before, but hardly impossible. Until "al-Qaeda Central" has been surfaced and destroyed, there will be no rest because force protection overseas is imperfect, and homeland defenses cannot be perfected against the many infiltration routes and likely domestic sympathizers that exist, as well as the innumerable forms of deception that are possible.

9. Contingency planning cannot rule out threats by which one or more WMD-capable states transfer WMD capabilities to terrorist organizations to carry out clandestine attacks against U.S. or Western interests.

None of the studies specifically forecasts WMD-capable states transferring WMD to terrorist organizations, but the intelligence estimates and several other studies are concerned that lowered contemporary inhibitions about the use of WMD and the hostile agendas of regional adversaries could lead to state cooperation on WMD with sponsored terrorist organizations. The same speculative logic and incentives to preserve deniability might eventually lead to adversary state cooperation on an *ad hoc* and opportunistic basis with other terror organizations that have no history of state sponsorship. This logic becomes more compelling and the real world risks almost certainly rise when the United States and its coalition allies engage a regional adversary on its own turf. A persuasive speculative scenario in the studies is the option of a regional adversary that fears regime change to attempt to deter by implicitly threatening, or to retaliate against U.S. and allied intervention by, diversionary terrorist attack in the homeland. The possibility that Saddam Hussain might adopt such a tactic was clearly a concern in the build-up to the invasion of Iraq in March 2003.

10. Development and deployment of strategic nuclear capabilities by post-Soviet Russia is still resource-constrained. In emerging China, development and deployment of strategic nuclear capabilities has been technologically constrained. Regardless, these capabilities are moving forward and could reach new levels that pose significant challenges by 2025.

This Russia- and China-related consensus proposition is reflected in the two DIA intelligence statements represented, and the NIC's *Mapping the Global Future – Report of the 2020 Project*. Each was concerned with a larger geopolitical picture. The DIA forecasts were

concerned not only about WMD threats from future regional proliferation and terrorism, but also about the future strategic offensive and advanced conventional military capacity of Russia and China to challenge the United States or constrain U.S. regional power projection. Hence each sought to project in general terms Russia's and China's development, modernization and deployment of their latest strategic missiles, theater nuclear military systems, and related capabilities. The intelligence assessments recognize that Russia and China both have had CW and BW programs, but the primary thrust of their WMD projections about both countries is strategic nuclear, space, and power projection capabilities If their forecasts have a common implicit concern about CW and BW, it is that Russian and Chinese technical knowledge may be divulged to other countries. One of the chapter authors in the *Gathering Biological Storm* book (Michael Ainscough), bases his forecasts of "Next Generation Bioweapons" on reports from former Soviet defectors about past developments in the Soviet BW program, but his estimate of where the most likely future BW challenges will come from emphasizes developing countries that are likely to adopt asymmetric strategies, rather than Russia.

11. Russia, China, and North Korea have been at the forefront of WMD supplier countries. These states, as well as emerging offshore powers like India, Pakistan, Iran, Brazil, Argentina, and Venezuela, may largely determine the rate and shape of future WMD proliferation.

Virtually all the nuclear proliferation and composite WMD studies categorically agreed that the key state sources of nuclear and long-range missile proliferation for decades have been the trio of Russia, China, and North Korea, and that barring major changes in their policies or incentives, they are likely to continue preeminently in that role for the foreseeable future. A number of the studies, however, forecast that emerging powers – particularly India, Pakistan and Iran – could also play significant future roles as suppliers in the nuclear and missile proliferation domains. One study, the Naval Postgraduate School's *Nuclear Weapons Proliferation: 2016*, suggested that by 2016, Brazil, Argentina and even Venezuela potentially could enter this league.

Military Technology

1. Emerging ballistic missile states, like North Korea, Iran, and Iraq, are developing long-range ballistic missiles capable of striking parts of Europe and the United States with NBC warheads. North Korea may have such a missile before 2010 while Iran may succeed by 2015.

During the Cold War, the only states that had long-range ballistic missiles in strategic arsenals were the two superpowers and the three other classical nuclear weapon states, Britain, France and China. During the last three decades of the Cold War, ballistic missile and cruise missile proliferation took place in a significant number of developing countries, although most of this proliferation was of Soviet-origin – Scud-based short-range ballistic missiles and anti-ship cruise missiles. By the end of the Cold War, inherent long-range ballistic missile capability was present outside the five traditional nuclear powers in the space

launch programs of a small number of states, including Japan, India, and Brazil. In the 1990s, the pace of programs that aimed at long-range ballistic missile development picked up in developing countries, particularly in North Korea, but also in Iraq and Iran. By the mid-1990s, concerns existed that North Korea's ballistic missile program was developing a Scud-derived Taepo Dong missile system with intercontinental range. This missile was believed to have the potential to reach the United States carrying a WMD warhead, and might reach that milestone earlier than previously estimated by U.S. intelligence analyses. The Rumsfeld Commission was formed by Congress to provide an independent analysis and forecast of emerging ballistic capabilities in emerging missile states such as North Korea, Iran, and Iraq. Its analysis and July 1998 report drew not only on then available intelligence findings and industry model analysis but also on new assumptions about how the standards and practices of emerging missile programs differed from the classical ballistic missile programs of the Western powers and the Soviet Union (see proposition 2 below) in order to expedite and thus shorten development and deployment timelines. In essence, it judged that the ICBM threat from emerging missile powers was much closer at hand than intelligence estimates suggested.

The sample of studies also contains the NIE on the ballistic missile threat developed in 2001, three years after the Rumsfeld Commission report, with its main conclusions published in an unclassified summary in December 2001. The NIE summary forecast of ICBM-capability in North Korea and Iran is encapsulated in proposition 1. The summary concluded that the U.S. should expect to face an ICBM threat from both North Korea and Iran by 2015. While the NIE acknowledged that the Rumsfeld Commission report methodology had influenced the analysts compiling this NIE, what remains interesting about the final forecast, despite the reference to calendar years, was its vagueness regarding exactly when North Korea (which had recently instituted a moratorium on missile testing) and Iran could be expected actually to cross the threshold of ICBM capability. Published before the March 2003 invasion of Iraq, it also attributed greater long-range capability to Iraq's missile program than appears in retrospect to have been warranted.

2. The pattern and pace of development of long-range missiles by states such as Iran and North Korea differ from superpower programs during the Cold War. Specifically, they conduct few full-scale tests and produce weapons in small quantities. These states may deploy a nuclear or WMD-equipped long-range missile ready for launch against the United States with little or no warning.

This proposition reflects a 1998 finding of the Rumsfeld Commission that was adopted by the NIE preparers in 2001, to the effect that the development and testing practices of the emerging missile powers was strikingly different from the practices maintained by the superpowers. The superpowers tested each type of missile repeatedly during development before making commitments to produce and deploy each system, and then typically produced relatively large numbers of each system for deployment. The emerging missile powers appeared to be satisfied with just one or two tests of a new system before deciding to

produce and deploy it, but also produced very few missiles for deployment, overall a striking break with past patterns. The implication was that basing forecasts on the classical assumptions regarding missile development would not work well to estimate the timeframes of the emerging missile powers. The latter might complete development of an ICBM-capable missile with few or no observable tests and deploy the system in small numbers quite suddenly, providing the United States with little or no time to respond. Clearly this would also make it far more difficult to intervene diplomatically in a timely fashion, and make strategic missile proliferation milestones much harder to evaluate.

3. Cruise missiles are spreading rapidly as a cheap and stealthy means of WMD delivery.

The studies that addressed missile proliferation recognized that cruise missile proliferation in the 1990s was providing another potential WMD delivery system of choice for emerging missile powers. Cruise missile platforms and technology were more widely available, commercially and as conventional naval armaments, from Western sources as well as Russia and China, and acquisition is generally much cheaper than for ballistic missiles.

While the assessed studies that include cruise missiles in their analyses do not provide country-specific forecasts of WMD-capable cruise missiles acquisition, they point to the increasing adaptation of cruise missiles to air-, sea-, and land-based variants, the inherent capacity of cruise missiles to carry BW and CW warheads, and the evident appeal of incorporating guidance systems using GPS signals for targeting accuracy and navigation to evade traditional defenses. India and Pakistan as *de facto* nuclear weapon states, and Iran as a likely nuclear proliferator, are actively pursuing nuclear-capable cruise missile delivery options.

In the same generic category, some of the assessed studies forecast the accelerated spread to states of concern of unmanned air vehicles (UAVs) as lighter WMD delivery platforms, and foresee that these technologies may also become accessible to well-funded terrorist organizations as potential mechanisms for remotely controlled dissemination of BW agents.

4. Biological weapon technologies that will be developed through advances in biological science and genetic engineering will include genetically modified, naturally-occurring pathogens (e.g., anthrax and smallpox) that are safer to handle and deploy, more infectious or toxic, more difficult to detect, more drug resistant and harder to treat, and with a variety of other self-enhancing or self-limiting characteristics that evade timely discovery and response, and that conceal the identity of perpetrators.

Forecasts of BW developments in our assessed studies sample are primarily science- and technology-based descriptions of possible biological weapon types rather than political-military assessments of particular actors that may develop, stockpile and use BW agents. These forecasts are driven by the scientific logic of understanding avenues that will open up as a result of experimental work in the biological sciences and genetic engineering. The

emphasis is not on military technologies, e.g., physical delivery systems or active defense interceptors in the conventional military sense, but rather on biochemical and physiological pathways for transmissivity and human infection with pathogens. The forecasts anticipate that development of biologically modified traditional pathogens as bioweapons is just around the corner. Some of the assessed studies note that low-tech BW threats to agriculture and livestock are already with us and warn us to expect related agro-terrorist attacks that could be economically debilitating.

5. By the second half of the 21st century, genome research and biological innovations will lead to development of "advanced biological warfare" (ABW) agents - entirely new kinds of bio-engineered bacterial and viral agents and delivery mechanisms, including Binary BW, Designer Genes and Life Forms, Weaponized Gene Therapies, Stealth Viruses, Host-Swapping Diseases, and Designer Diseases.

The forecast of BW development two to three decades out anticipates entirely new classes of disease-producing agents, dissemination pathways, and possibly even the means of engineering pathogens to differentially select and target various categories of human beings, including groups based on age, national background, or ethnic or racial differences. The potential challenges to intelligence, attack detection and warning, data security management, and consequence management become extraordinarily complex and difficult to predict or parse. These potential challenges are replete with elements of surprise.

6. Innovation in the fields of cybertechnology, nanotechnology, energy, and propulsion can be expected to lead to new types of WMD and delivery systems, that may transform combat techniques, military organization, and battlefields.

Apart from the science-based biological studies, the most far reaching WMD technology assessment in our sample, and certainly the most technologically-specific, was offered by the *Air Force Futures Project: Emerging WMD Technologies (2007)*, which emphasized physics-based technologies, including information technology. It sought to explore what new types and new kinds of WMD might emerge from technological innovation in cybertechnology, nanotechnology, advanced forms of energy release, and novel means of propulsion. Its underlying concern was anticipating WMD-capable *military* technologies that would challenge the U.S. Air Force on future battlefields.

It was the most specific of the forecast studies in its description of military technology possibilities. It also sought to clarify the difference between "weapons of mass disruption" and "weapons of mass destruction" that could emerge as challenges to U.S. national security and operationally to the U.S. Air Force. It chose not to conflate WMD*isruption* with WMD*estruction* but rather to separate them in its military technology forecasts. Cyber threats, for example, were deemed by the study largely as threats of mass disruption rather than threats of mass destruction. The study also distinguished between technological innovations that could be *enablers* of weapons of mass destruction, and the WMD themselves.

Information technology and novel propulsion technologies were considered enablers of novel types of WMD. Nanotechnologies, on the other hand, could be represented in both categories, as enablers or as actual WMD, depending on their functions.

New military nano-technologies forecast for attack or dissemination include explosive microdust (nanoexplosives), nanobots serving as BW delivery systems or as micro-weapons themselves, and inhalable micro-particles to cripple personnel. Conceivable advanced energy forms of WMD include pure fusion weapons, novel non-nuclear energetics, microwave weapons, and new propulsion technologies for delivery of other WMD. Conceivable propulsion technologies would support ultra-light, long-range UAVs and space vehicles, and would derive from novel methods such as 'blast-wave propulsion' or the use of a 'slingatron' (means of accelerating projectiles).

Technology evolution was also forecast to make "traditional" WMD more lethal, deliverable and dangerous. An increased threat will come from making nuclear weapons programs harder to detect, more powerful but with smaller payloads, and from advances in the infectivity, virulence, persistence, and resistance if disease agents. The ability of state and non-state actors to develop and possess these weapons will improve.

With anticipated technology revolutions, not only will "improvements" to existing WMD occur, but new weapons with massively destructive effects may become possible. These new systems could come in different forms, whether new high explosives that when combined with affordable, long-distance UAVs can deliver a swarming effect and cause massive destruction, or new non-biological pathogen-like effects from nanites.

7. As the main geo-strategic competitors of the United States for the foreseeable future, Russia and China will continue to: (1) improve the survivability of their strategic assets; (2) modernize strategic nuclear offensive weapons and space-faring technologies; (3) develop and deploy advanced conventional weapons; (4) upgrade the military applications of telecommunications, information, and surveillance technologies, and; (5) exploit the concurrent WMD or WMD-support applications of the latter technologies.

Post-Cold War forecasts of competitive military technologies with WMD potential that could be developed in Russia and China are an obligatory as well as natural part of the intelligence reports in our sample, and of *Mapping the Global Future – Report of NIC's 2020 Project (2004),* but are burdened with uncertainty as to whether either Russia or China should be regarded as a future adversary or as a peer competitor. They also reflect uncertainty on how to estimate future technological prospects in either state. The consensus proposition reflects hedging forecasts that assume a competitive but not necessarily confrontational relationship with both Russia and China, as each seeks to enhance it national scientific knowledge and engineering power in every domain that has strategic and WMD content, including space. The implication is that Russia and China could once again, some day, be the leading sources of WMD threat to the United States. An underlying concern is that both

Russia and China are prone to use technology leverage in ways that can be seen as more permissive of WMD and missile proliferation than the United States and its Western partners.

8. Non-state entities seeking chemical, biological, radiological, and nuclear (CBRN) materials would be willing to use them without missiles. WMD attacks on U.S. territory – particularly by terrorists – are more likely to be from non-missile delivery means than by missiles. Non-missile delivery means are less costly, easier to acquire, and more reliable and accurate, and can be used with less risk of attribution.

The studies shared a high level of agreement on the proposition that the terrorist (or other non-state) WMD threats to the United States are not likely to be based on long-range missile delivery systems, but rather on other covert methods of delivery that are cheaper, easier to acquire, likely to be more reliable and accurate, and that lend themselves to anonymity. There were no studies in the sample that disagreed directly with this proposition.

9. Terrorists will use novel operational concepts to employ relatively simple WMD weapons for maximum effect.

This last consensus proposition on military technology forecasts that terrorist threats will be noted less for adoption of novel military technologies than for their operational ingenuity, e.g., attention to detail in covert preparation for attacks, and self-discipline in execution. As a general statement about the priority contemporary foreign terrorists would attach to hitting hard, suddenly, with spectacular public effects, and where the defender is ill prepared, this proposition may seem incontestable. If a low-tech approach can do as good or better a job of terrorizing a nation than a high-tech attack, the forecast suggests that the defenders should look there first. But several of the assessed studies would dissent from this proposition if it were interpreted to mean that terrorists would overlook well-publicized military technology developments in the biological and nanotechnology fields. For example, the possibility of using small UAVs as a means to remotely disperse a disease agent – over shopping centers or schools, for example – could easily be included in a foreign terrorist organization's playbook of options, if and when the means are available.

Opposing Strategies

1. Russia's "opposing strategies" will continue to be concerned with domestic economic recovery, rebuilding internal strength, and preserving core strategic delivery and WMD assets to balance against potential military threats from the West or from China.

Russia's opposing strategies following the disintegration of the Soviet Union were focused not on sustaining military confrontation but rather on cutting its losses – by reducing the economic burden of military assets, downsizing military forces, and restructuring the economy to shrink the public sector and take selective advantage of foreign trade and capital.

The contraction of the economy was stemmed by the end of the Yeltsin period. Russia had grudgingly accepted a stylized form of cooperation with NATO and the European Union, both of which expanded by taking in Eastern Europe states as members. Putin's ascent coincided with rising energy prices and Russian sales of oil and gas have reversed the nation's economic decline and revived economic growth and a measure of national self confidence. Politically, Putin has emphasized the reinvigoration of Russian national pride, a strengthening of central authority in Moscow, and new initiatives to revive Russian influence in the newly independent FSU states of Central Asia. But having fallen so far in the 1990s, Russia will need to rebuild its resources peacefully for at least two decades to recover a semblance of its strategic role.

Russia's opposing strategies will be calibrated to rebuild a positive image of Russia and to extend political and economic influence abroad, taking advantage both of Western setbacks and internal NATO or US-European quarrels, as well as U.S. tension with regional influentials like Iran. It will attempt to capitalize on Russia's still technologically advanced science sector and its heavy industrial and arms production systems. It has successfully expanded its trade with China and maintained its trade with India, and hopes to benefit from their respective surges in the world economy. As a technologically advanced but economically smaller state, post-Soviet Russia seeks to maintain military R&D in all strategic and space-faring fields, and resists implementing pledges to eliminate CW and BW programs and capabilities totally. Geopolitically, Russia's opposing strategies will be to encourage balancing reactions by emerging powers, particularly China, India, and Iran, to U.S. global preeminence. It will maintain and modernize its WMD capabilities at reduced levels to sustain its status as a strategic nuclear power and for continuing leverage and deterrence against hostile action by either the United States and NATO, or China.

2. China's "opposing strategies" will continue to focus on using its rapid economic advances to develop of a full spectrum of modern WMD, strategic, space-faring, and conventional military capabilities, including theater air power and blue water naval forces.

China's economic transformation from a relatively poor agrarian country to an international trading powerhouse since the Nixon/Kissinger rapprochement in the early 1970s is unprecedented. China's first priority is to continue to ride this remarkable trend and build a modern and prosperous society, making adjustments in its Communist Party-controlled political system to avoid serious outbreaks of internal political instability. It has avoided, since the end of the Korean War, major confrontations with Japan and the United States, as well as with Russia, while using the intervening decades to modernize and professionalize its armed forces and strategic nuclear and space systems, with improvements in warning, command and control, and ICBM survivability. Its CW and BW programs were a legacy of World War II but probably have been kept up to date through R&D. It still has a long road ahead to equip its conventional air and naval forces with advanced conventional arms and blue water naval projection capability. China and the United States have both worked to avoid major military confrontation over Taiwan, and have cooperated closely for several

years in seeking, along with Russia, Japan, and South Korea, to negotiate denuclearization of North Korea. China is also careful to avoid provocations of Japanese nationalism, despite a deep undercurrent of animosity left over from World War II, and one may surmise that China's interests in not risking the awakening of nuclear and strategic missile ambitions in Japan remains beneficial to Chinese security as well as to broader regional stability.

China's opposing strategies probably will seek to limit U.S. military dominance East Asia, but not to weaken the United States as a society or economy directly, given that economic interdependence has become extensive. China will seek to outgrow the United States peacefully. But there are potential collision points that could impair relations or precipitate conflict. China will hedge against overt Taiwanese declarations of independence and seek to shrink the U.S. security commitment to Taiwan. Other frictions with the United States may grow over foreign energy and mineral resources – for which China's appetite has become voracious – and possibly over U.S. military relations with India should they take the form of proactively arming India to contain China. China will seek to balance U.S. influence in Southeast Asia by warm overtures to regional states and by seeking to win acceptance of itself as an unspoken pillar of security and stability in that neighboring region.

3. Both Russia and China will cultivate allies to support opposing strategies to U.S. global preeminence. These strategies may lead them to export conventional and dual-use military technologies to WMD-interested regional states – especially oil suppliers -- to strengthen regional relationships opportunistically.

None of the assessed studies attempts to determine directly whether Russia and China use WMD and missile proliferation deliberately to replace U.S. influence with their own in strategically important regions, or to secure access to or control over energy and mineral resources. But if one were to infer from their collective probes of the future WMD behavior of Russia and China why most conclude they have been and continue to be, along with North Korea, the leading suppliers of WMD-related and missile technologies to the Middle East and South Asian regions, one would be led to the impression that proposition 3 represents an uneasy consensus – perhaps uneasy because the implications might not sit well with the politically correct mainstream of post-Cold War U.S. foreign policies toward Russia and China. Several of the nuclear nonproliferation studies that lean toward the validity of this proposition in the past nonetheless emphasize evidence of course corrections by Russia and China that augur well for their nonproliferation commitments in the future.

4. Regional states that have acquired WMD often do so to counter threats from regional rivals, elevate their status and regional influence, or engage U.S. and Western assistance. But those regional states that are durable adversaries of the United States are likely to harbor asymmetric opposing strategies that assume their WMD capabilities would serve as deterrents against direct attack by a conventionally superior U.S. force.

This consensus proposition on WMD-backed asymmetric political-military strategies in sensitive regions probably is the proposition most strongly and universally subscribed to by all the assessed studies. It enumerates the most common dominant motives for regional state acquisition of WMD: filling status aspirations, pursuing regional dominance, compensating for security deficits against rival neighbors, and in some cases aiming for the capability to deter outside intervention. The proposition further links the last motive to the opposing strategies that local WMD-equipped antagonists might employ against U.S. intervention.

Collectively, these opposing strategies are asymmetric in nature, contests of will between the weaker but locally rooted and autocratically-governed nation and the more physically powerful but politically and culturally alien outsider. They recognize the overwhelming conventional military superiority of the United States and its closest Western allies, and the existence of nuclear weapons as an American trump card, but also shrewdly weigh U.S. and allied inhibitions in exercising their military power (given their need for sustainable domestic public support) when faced by local adversaries armed with and willing to employ WMD on the battlefield or against nearby staging facilities, whether the WMD is nuclear, biological, or chemical.

A thoughtful chapter on the "Prospects of Biological War in the Middle East" in the *Gathering Biological Storm (2002)* compendium offers a carefully scripted outline of what a regional conflict with U.S. engagement and adversary BW use plausibly might look like. It lays out the military strategy and tactics that a BW- and missile-equipped regional adversary could rationally play out in seeking to deter or defeat U.S. intervention and avoid complete military defeat or regime change.

5. Regional adversaries with WMD may develop other asymmetric opposing strategies to exert preventive leverage against U.S. or Western decision-makers. Examples of this include deploying cruise missiles clandestinely in merchant ships, or by cooperating with or working through terrorist organizations to infiltrate and position WMD that could be activated in the homeland and publicized and used on short notice.

This consensus proposition is supported by a few of the assessed studies more strongly than by others. The caveat of the weak supporters would be that scenarios of this kind cannot be ruled out entirely, but would be of low probability, partly because the perpetrators could not really count on anonymity for long, the retaliation would be severe, and deterrence still counts with decision makers of states. Others would argue that the delivery method of

collaboration with terrorists is a more credible strategy for coercion by a high-risk taking state than its resort to covertly deployed and launched cruise missiles against U.S. territory. This proposition has the virtue nevertheless of alerting us to contingencies that may seem to be low in probability, but that could jump to a higher level of plausibility if they were ignored.

6. Terrorist organizations like al-Qaeda will find justifications for collaborating on the piecemeal acquisition and use of each type of WMD to amplify their already articulated "opposing strategies."

This consensus proposition is generally shared by those assessed studies published after 9/11 that address the prospects of WMD terrorism in one form or another. The opposing strategy of al-Qaeda and related Islamic extremists relies on spectacular attacks that kill many civilians and arouse horror, but none of the successful attacks thus far has employed WMD. WMD use probably would be a force multiplier. What is most ominous is al-Qaeda's affirmation of its willingness to use WMD and its public justification of such use in religious and legal terms as part of its war with the United States and Israel.

7. States that are determined to acquire (or supply) WMD components will develop and refine opposing strategies against proliferation detection and interdiction in order to conceal their facilities and capabilities and harden them against air attack, and thwart or circumvent international nonproliferation controls.

This last consensus proposition is on the opposing strategies of the community of proliferating states and their black market suppliers to effective nonproliferation controls. Like the opium and heroin market, and criminal organizations, those who have vested interests in WMD and related illicit activities will fight the regulations and authorities that prohibit WMD and seek to shut down illicit activities. Many of the individuals involved will have no direct interest in the use of WMD themselves or in the enabling technologies; some are merely doing a job they are paid to do, and others may be involved because their services are indispensable and enable them to profit immensely. Their opposing strategies are indirect and evasive, based on money and influence-peddling networks, or outright corruption. They do not pose direct security threats to states. The fact that the cumulative fruits of their labors do create security threats is too remote for them to have feelings about. They would be relatively easy to shut down if they had no patrons in positions of state influence.

Areas of Disagreement

WMD Proliferation Outcomes

Forecasts of proliferation outcomes could specify who would get what kinds of WMD by when, in what military operational quantities, and when those actors would actually use WMD in what circumstances. By and large, most of the forecasts were similar in not being specific on these benchmarks, and disagreements about WMD proliferation outcomes therefore do not stand out. There were no rival forecasts, for example, of when North

Korea would go nuclear (as it actually did in 2006), or when Iran might do so, or on what scale. None of the forecasts anticipated Libya's reversal in 2003. Some of the studies forecast that India and Pakistan would continue to enlarge their arsenals, but without attempts to specify numbers of weapons or types of weapons, deployment timeframes, or when new military capability thresholds would be crossed.

The most specific forecasts were those of the intelligence community (IC) that focused on missile proliferation and that attempted to estimate when North Korea, Iran, or Iraq (prior to 2003) might develop an ICBM. These provided timeframe references, but were nonetheless quite vague, as mentioned in the earlier discussion of the consensus propositions. The IC forecasts and those in most of the other missile studies also covered shorter-range ballistic missiles and cruise missiles and essentially agreed on the "who" – which countries were acquiring them – as a pool of the "usual suspects." There were no surprises there. If the forecasts differed, it was on how to measure the pace of missile proliferation (how rapid and wide) and how to characterize the military threat to the United States, e.g., what probability of use, by whom, in what circumstances. Some addressed these as near-term problems or matters of urgent concern – as was the case with the IC projections of ICBM potential. Others treated the problem as real but emerging more gradually and with less certainty about the specific threats and their defense implications, as in the article on "What Missile Proliferation Means for Europe" (2006).

The nuclear proliferation forecasts generally agreed on the set of "likely suspects" and "regions of concern." All treated Northeast Asia and the Middle East as the most potentially volatile regions in which new nuclear (and missile) proliferation should be expected within the next decade or two. If there was an area of disagreement, it was a general one of whether and when a "tipping point" would be reached, bringing a cascade of new nuclear proliferation. Some studies or authors seemed to regard that as a likely eventuality. On that point, there were few if any sharply framed disagreements, but rather a nuanced difference in emphasis – either more optimistic or more pessimistic that an "explosive burst" of proliferation could be headed off by suitable policy measures. Readers probably would agree with the author here to assign the majority of the studies to the pessimistic forecast category. The more optimistic studies on this tipping point question are the Carnegie Endowment's *Deadly Arsenals* (2005) and the CSIS-William & Mary book, *The Nuclear Tipping Point* (2004). There are also elements of optimism among some of the authors in the Naval Postgraduate School study, *Nuclear Weapons Proliferation 2016* (2006), and the Sandia workshop paper by Lewis Dunn, *The Changing Face of Proliferation*, analyzes both outlooks without coming down in favor of one or the other.

Interestingly, one of the assessed studies, *Air Force Futures Project: Emerging WMD Technologies* (2007) reflected disagreements internally on how to classify future WMD based on evolving technologies. In this case, the question was: What kinds of WMD may emerge in the future from evolving technologies? The study dealt with biological and physical technologies, but mainly physical. The study approach involved reading and assessing a series of studies done

by others on the subject of technology evolution and then interviewing a group of experts to help adjudicate or refine propositions found in those studies. Experts who were interviewed disagreed on three points: (i) whether evolving information and cyber technology, and certain energy release technologies like Microwave, could become "weapons of mass destruction;" (ii) whether "weapons of mass disruption" could be considered "weapons of mass destruction;" and (iii) whether the definition of the term "weapons of mass destruction" should be widened to include *cumulative* mass destruction by conventional weapons or by inflicting a large number of deaths by successive actions over a longer period of time (rather than in a single strike).

The authors of this future WMD technologies study for the Air Force concluded on point (i) that IT, cybertechnology, and Microwave technology probably themselves would *not* produce weapons of mass destruction), but could potentially become enabling technologies for WMD. They concluded on point (ii) that WM*Disruption* should *not* be equated with WM*Destruction*, but that the former could in some cases serve as enablers for the latter. They concluded on point (iii) that it would inadvisable to expand the definition of WMD beyond classical NBC, especially not in advance, because this could lead to charges by foreign actors that U.S. military R&D was developing WMD and these allegations could politically constrain future U.S. choices of weapons that did not fit the classical definition of WMD. To reduce U.S. defense flexibility by redefining WMD in advance, they argued, would be imprudent.

WMD Proliferation Drivers

In the sample of studies, three different kinds of variables were associated with WMD proliferation as drivers (or inhibitors) among state actors:

- *Internal factors* such as the motives of governments, often seeking WMD to counter perceived external threats, or in some cases to elevate status, and the availability of internal resources and other capabilities to pursue WMD;
- *External factors*, such as objective threats from larger, heavily-armed or aggressive neighbors, the occurrence of war, and externally provided security, if available; and
- *Exogenous factors*, such as globalization and technology diffusion, that increase technical availability or access to WMD knowledge and technologies. All of the studies seemed to agree that some mix of these factors would drive most WMD proliferation in states.

The studies exhibited no wide or sharp disagreements overall on what should be included as relevant drivers, but there were some differences among the studies in the drivers that were treated as paramount for analytical and forecasting purposes. For instance, the narrower science-based BW studies – *Living Nightmares: Biological Threats (1999)*, *Biotechnology: Impact on Biological Warfare (2003)*, and the BW component of *Air Force Futures Project: Emerging WMD*

Technologies (2007) – tended to share a view that the diffusion of biological science and dropping costs of scientific exploration and bioengineering would open doors to advanced biological weapons and techniques that would be pursued by bad actors as a matter of course – a line of reasoning bordering on technological determinism for BW proliferation.

Assessments of broader scope, such as the 2001 and 2007 DIA statements, as well as *Mapping the Global Future – Report of NIC's 2020 Project* (2004), and the ballistic missile forecasts, tended to emphasize globalization factors as drivers of technological opportunity, but generally were focused on the motives and settings of particular state actors for explanations of the drivers of their forecasts of where BW and other forms of WMD acquisition could be expected.

Those studies that focused most specifically on nuclear proliferation generally paid more attention to state motivations and security variables than to globalization factors as the key nuclear proliferation drivers. Several of these nuclear-specific studies, notably the *Nuclear Tipping Point* (2004) and *The Changing Face of Proliferation* (2005), emphasized the role of U.S. security alliances or assurances with allies and friends as a counter to state motivations for nuclear weapons capability stemming from external security threats. But this factor of U.S. security provision was not available to a number of state actors forecast to be likely nuclear proliferators, and *The Changing Face of Proliferation* noted in its survey that the earlier importance of U.S. security provision as a barrier to nuclear proliferation has diminished in the current era. This study also noted that the single most powerful driver of a burst of new nuclear proliferation could be an event in which nuclear weapons are used – successfully.

On the question of what may drive terrorist interest in acquiring WMD, there were no noteworthy differences in the studies. The motivations of non-state actors were considered the primary driver. At the same time, the forecasts that dealt with the subject of terrorist WMD potential often were concerned with the possible avenues of terrorist acquisition of WMD, and typically reflected the concern about eventual leakage of nuclear weapons grade material or even removal of nuclear weapons themselves from nuclear weapons states by insider theft and black marketeering, or terrorist infiltration and intrusion into nuclear or other WMD storage sites.

One BW study, *Prospects for Biological War in the Middle East* (2002), argued that the drivers of BW acquisition and the drivers of BW use are not necessarily the same and may be quite different. This scenario-based analysis of prospective use of WMD in a hypothetical regional conflict stood out from the others in that most of the studies were limited to forecasts of where state WMD proliferation was most likely to occur rather than forecasts of what might transpire in subsequent conflicts with (or between) WMD-armed states.

Disagreement on Other Matters Relevant to WMD Forecasting

One of the more unusual assessed studies – *Thwarting an 'Evil Genius,'* the sole study mandated to try to ascertain what an "evil genius" could do were he to organize an attack on

the United States homeland that exploits U.S. vulnerabilities for maximum psychological and political effects[2] -- went at least partly beyond the WMD proliferation focus of the other assessed studies to consider orchestrated attacks on the homeland with conventional methods, not only WMD. This should not necessarily be construed as a disagreement with the main body of forecasts of WMD proliferation. But as an effort to think outside the box, the participants in this study identified a number of potentially catastrophic threat scenarios, several of which did not depend on WMD use at all.

This study's "thought process" would lead its audience to consider that some of the most dangerous threats to the domestic stability of the United States could come from clever attacks (e.g., a sustained campaign of bombings of school children) that did not depend on WMD. It did not suggest that WMD proliferation was any less important a threat to U.S. national security, merely that huge societal injury could be inflicted by attacks using more mundane techniques. The implication for WMD forecasting is that the same pool of highly intelligent hostile actors that might consider using WMD to strike at U.S. vulnerabilities could also consider using other means and techniques for equally profound objectives. In constructing a forecast of WMD use, the conclusions of this study, it could be seen as narrowing the odds of forecasted WMD use in pursuit of objectives that could also be pursued by non-WMD means.

How confidently the United States can rely on deterrence of WMD use by states and non-state actors has been an area of controversy and could have been a subject of forecasts and disagreements. In fact, many of the assessed studies showed some awareness of the issue, but none addressed it as a focal issue or as a forecast. Generally the studies that touched on this issue seemed to agree that U.S. efforts to deter rogue state use of WMD against the United States or its forces could be expected to be effective, although they probably would not be conclusive under all conditions, especially under active war conditions. Generally the studies would also agree that U.S. means of deterrence could not be counted on to deter terrorist use of WMD.

Wild Cards and Potential for Surprise

Most of the assessed studies acknowledged the potential importance of surprises in the WMD domain as generic factors or abstract conditions that could alter WMD proliferation outcomes. Only a small number of the assessed studies identified possible surprises as concrete events or milestones that can be readily described. The few studies that dealt with surprise more concretely flagged potential surprises in the following areas:

[2] The participants in this workshop were told to craft scenarios of what an "evil genius" (a lone malefactor or an organized terrorist group) could do to damage American society and government. They were given only two restrictive parameters, first that the attacks had to be conceivable in the next five years, and they had to employ existing technology.

- *The technologies that could produce new types of WMD, and those new types of weapons or methods of employment.* The findings of the science-based biological studies that illuminated advanced biological warfare agents, methods of employing them and the challenges to response probably would not pose surprise to specialists in this subject – at least not today – but might to the larger national security community of WMD and policy analysts. However, the futuristic findings of the *Air Force Futures Project* on prospective WMD technologies and methods of employment surely contained some items that would surprise the broader national security community, particularly in the areas of nano-weapons, "swarm-attack" operational methods, and novel long-distance propulsion technologies.

- *The effects on the international system of a "surge" of new nuclear proliferation.* Two of the nuclear proliferation-focused studies, *The Nuclear Tipping Point* and *The Changing Face of Proliferation*, address surprise at the systemic or macro level. The idea of a nuclear tipping point itself points to a looming potential surprise of a collapse of nonproliferation regime elements and a burst of nuclear proliferation by states – a threshold that the forecasters believe is possible but hope is avoidable. The central argument of the authors of *The Nuclear Tipping Point* was that while reaching a tipping point is possible, it is also possible that appropriate policy actions and commitment by the United States and the international community could entirely avert it. Part of the basis for this argument is that many of the factors that states weigh in decisions on whether to acquire WMD would lean against doing so, and is illustrated by states like South Africa and Libya reversing course to give up former WMD programs. *The Changing Face of Proliferation* offered a number of surprise-oriented vignettes, but a key one related to forecasting whether (and why) a tipping point could be reached was its judgment that the free-good value of U.S. security provision that once played a paramount role as an inhibitor of new nuclear proliferation has been significantly depreciated in the perceptions of the international community.

- *The possible effects of an actual WMD use (especially nuclear use) on subsequent proliferation decisions by state actors, and on efforts to rally the international community to prevent further WMD proliferation.* A closely related "wildcard" point was that the next "successful" use of a nuclear weapon could be a critical driver of wider and more accelerated proliferation. But it could also serve to catalyze stronger nonproliferation responses, a point emphasized in *The Changing Face of Proliferation*, which addresses how WMD surprise events could be an ally of nonproliferation goals provided the international community is ready to act and act intelligently. Forecasting real possibilities imaginatively and in an anticipatory mode is actually demonstrated in this article as a way of making it a tool of potentially effective policy response. The article suggests that the key anticipatory issue in how to bend the outcomes of our current forecasts in a favorable direction is being prepared to deal with a generic WMD surprise – especially a WMD use event, such as the first use of nuclear weapons since 1945, or a terrorist or rogue state's first known use of biological weapons against the United

States. Surprises can work in a favorable direction. A messy first use of biological weapons by a terrorist organization, for example, might be used to turn the leaders of BW-aspiring states, even rogue states, away from considering use or retention of those weapons. Similarly, intelligent international response to the first use of nuclear weapons since 1945, perhaps in South Asia, or perhaps closer to home, could be used to characterize and remediate the event where it occurs, while galvanizing stronger international controls against further proliferation.

- *New kinds of organizations that might be formed by proliferator states to enhance their acquisition of WMD capabilities, and new security relationships between emerging nuclear states and their allies or clients that could result from new WMD proliferation in the international system.* Both *The Changing Face of Proliferation* and the Naval Postgraduate symposium on *Nuclear Weapons Proliferation: 2016* anticipate related WMD developments that might surprise many national security observers who do not follow proliferation closely. The disclosures of the A.Q. Khan nuclear smuggling network led authors in these two studies to consider how other offshore phenomena made plausible by globalization could emerge to enable proliferation by determined states, e.g., through use of offshore sites for nuclear explosive testing, or offshore facilities to conceal production of nuclear components. *The Changing Face of Proliferation* also anticipates surprise by delineating scenarios in which nuclear weapons might be used by protagonists in coup-making or civil war within emerging nuclear powers such as Pakistan, and suggests the likelihood of a proliferation nexus being formed with criminal organizations. With respect to new relationships where the U.S. nuclear umbrella does not exist, the two studies note the surprising possibility that an emerging nuclear power like Pakistan might provide extended nuclear deterrence to Saudi Arabia to offset the effects of a nuclear weapons program in Iran. More specific state-related surprises in the 2016 Symposium's section on Southeast Asia include the possibility that recently growing nuclear transactions between China and Burma (or Myanmar) could pose an eventual WMD proliferation threat, and the assessment that Indonesia's efforts to build a civil nuclear power program probably would not. The Latin America section of the 2016 Symposium identifies Venezuela potentially as a nuclear proliferation problem.

- *New ways of attacking U.S. domestic vulnerabilities that rank order unconventional homeland threats, some employing WMD and others more mundane means.* The *Thwarting an 'Evil Genius'* report identified and ranked several types of attack that would represent surprises in their ingenuity and in the ways in which they contrast with the typical planning against homeland threats attributed to al-Qaeda terrorists. The types of attack ranked in order of "greatest risk" were:

    1. ***The Kiddie Bomb*** – a foreign or home-grown terrorist recruits small cells of like-minded individuals to launch a sustained campaign of school bus

bombings. The campaign adapts/escalates to include other target classes such as churches, sporting events, etc.., to undermine public confidence in government.

2. ***Synthesized, Resistant, Hard to Detect Smallpox*** – a malevolent individual bent on mass killing develops and releases a new strain of smallpox.
3. ***Dual Campaign of Dirty Bombs and Nuclear Threat*** – a group of terrorists, possibly with state support, orchestrates a campaign of attacks across the United States, detonating radiological dispersal devices (RDDs). The aims are to inflict economic damage and to exploit public fear of radiation. To exacerbate anxiety, the terrorists plant traces of highly-enriched uranium and claim to have a fission bomb. The group relies on American media to whip up public hysteria of imminent nuclear attack.
4. ***Attacks with Dual Bio Agents against Mega-Malls*** – an anti-globalist loner recruits unwitting accomplices to infect 3-4 U.S. shopping malls with two different types of biological agents. The aim is to damage the American economy during the critical holiday shopping period. Use of dual bio agents delays prompt identification and treatment of the infected.
5. ***The Perception Bomb*** – an internal or external group infects a small number of migrant workers in the United States and Mexico with a contagious viral disease to fuel public demand for border closure. The attack is intended to create economic disruption and exacerbate societal tensions.
6. ***Serial Arson Campaign*** – a loner conducts an ongoing campaign to set buildings, whole neighborhoods, and the countryside ablaze in an effort to inflict casualties, property loss, indirect economic costs, and otherwise disrupt society.
7. ***Civil Aviation—Nuke—Iran*** – an Islamist group bent on provoking U.S. military operations against the Muslim world uses corporate jets rigged with shaped charges to damage or destroy 2-3 U.S. nuclear power reactors. The operation is conducted under a "false flag" to implicate Tehran, thereby provoking U.S. military "retaliation" against Iran.
8. ***The Katrina Bomb*** – a hostile element launches an opportunistic attack against a region stricken by a natural disaster to amplify the consequences.
9. ***Variegated Kaczynski*** – an exceptionally bright domestic terrorist launches a campaign of attacks against schoolchildren and infrastructure targets using such low-tech means as a sniper rifle, incendiary devices, and bombs. Operating alone, this terrorist is extremely difficult to detect beforehand and to pursue even after his campaign becomes clear.

These nine imaginative conceptions of how an "evil genius" – whether as an individual or with the support of a dedicated group – might seek to harm the United States fundamentally, weaken the resolve of the government, and create social distrust are aptly framed to test for logical gaps in homeland security threat anticipation and response planning. The conceptions are not forecasts, of course, in the usual sense of that term.

Observations on Methodology

The sample of assessed studies contained a variety of traditional analytical methodologies for forecasting future WMD conditions. Table 2 lists the general features of the methodologies employed (bearing in mind that some studies had two or more of these general traits at the same time).

Table 2. General Methodology Traits	
Estimative Intelligence	4
Collective Judgment	8
Individual Judgment	6
Trend Analysis	5
Technology-Threat Inferences	4
Quantitative Data Analysis	2
Alternative Futures (Scenarios)	4
Sen. Lugar Polling NP Experts	1

Estimative Intelligence simply refers to the institutional methodology underlying intelligence projections based on assessments of technical as well as political-military sources. *Collective Judgment* refers to the methodological use of panels of experts or a symposium of authors to generate the forecasts. *Individual Judgment* refers to a study produced by an individual expert (or pair of experts), usually based in a think tank or in academia. *Trend Analysis* refers to studies that based their forecasts on extrapolating trends, focused usually on real world WMD technology acquisitions and political trends in key states and regions. The methodology of *Technology-Threat Inferences* refers to the science- and technology-based studies that forecast new types of WMD expected to emerge in due course from natural science and engineering trends. *Quantitative Data Analysis* refers to studies that applied statistical analysis to country data sets to determine which variables have driven WMD proliferation in the past and could be expected to in the future. *Alternative Futures (Scenarios)* refers to studies that employed scenarios to visualize future possibilities that would not be easily discerned in the extrapolation of trends. Quite different from all the others, one study sponsored by Senator Lugar polled national security experts to generate forecasts about WMD outcomes at home.

What may be of greater interest here, however, is a qualitative discussion of how the study methodologies performed, either to forecast the status of contemporary WMD proliferation,

or to generate key questions about what to look for in anticipating future changes in the scope, rate and patterns of future WMD proliferation. As a caveat, if one were looking beyond what was already known for relatively precise and concrete forecasts of who would have, or use, one or another kind of NBC by a date certain, none of the forecasts represented here stood out as particularly trenchant, specific, or satisfying. This is not to belittle their utility. We probably would be far more adrift in our threat assessments, strategic warning sensibility, and response planning without these studies and others like them. But one would have to infer that WMD forecasting to date does little to resolve the prevalent uncertainties in the real world of WMD players. The art and science of forecasting WMD developments probably can be improved upon, but it seems unlikely that it will ever be akin to a crystal ball.

Following are more specific observations about the how the study methodologies made forecasts and generated key questions.

Forecasts of WMD Proliferation Status

The studies based on estimative intelligence and trend analysis go a long way toward portraying the actual distribution of WMD capability among particular states and regions of concern, and mapping the technical trends in the countries of concern. If one asked whether any of these studies overlooked a country or regional WMD proliferation trend that retrospectively appears to be critical, the answer would be no. If there were accuracy issues in the studies' forecasts of WMD and missile capabilities, they may have been on the high side in particular cases (as with Iraq prior to the discoveries on the ground following the March 2003 invasion, or in the forecasts that attempted to provide specific timeframes for ICBM development in Iran and North Korea), but they were not necessarily wrong on judgments about regime intent or the direction of technical trends. They were also largely effective in depicting what was technically possible, and therefore on what long-term early warning would need to look for. They were unable to estimate whether and when North Korea would test a nuclear device, or to predict Iran's transit of uranium enrichment thresholds, but they were on track in describing WMD and missile programs and emerging capabilities, and indicating their implications. They were also indisputably on track in flagging the potential WMD-related instabilities in Northeast Asia, South Asia, and the Middle East.

Arguably, the areas of greatest weakness in the studies based on estimative intelligence and trend analysis was in the depth of their political analysis. This is not necessarily a shortcoming of the methodology employed, however. Rather it probably is due in large part to the intrinsic difficulty of predicting political outcomes with any methodology. It could also be attributed partly, however, to institutional insufficiency of resources devoted to gathering and analyzing political data on less familiar parts of the world. All of these studies noted certain possibilities of surprise, such as a WMD use in Northeast Asia or in conflict between India and Pakistan, hypothetical contingencies no well-informed WMD analyst would take objection to. None anticipated Libya's WMD proliferation-reversal in 2004, or

forecast the disclosure and extent of the A.Q. Khan nuclear smuggling network. None alluded to the possibility disclosed as a factual judgment in a recent NIE that Iran in 2003 closed down a previously active nuclear weapons design program.

Several studies relied on collective judgment (panels of experts) and alternative futures analysis as integral parts of their methodology. This collective judgment feature lends itself to addressing larger questions about the future of WMD proliferation. For instance, the *Nuclear Tipping Point* study – written by individual authors but under a collective framework of key questions – attempted to forecast the likelihood, or more precisely the contextual conditions under which, the nuclear nonproliferation regime might collapse in a sudden burst of nuclear proliferation. This analysis included the earlier history of states that started and then gave up nuclear weapons programs on both political and security grounds, and probed the circumstances that might lead states that have complied with the NPT to reconsider and exit from the regime. The net forecast of the study is at least mildly optimistic that a tipping point can be avoided. But the methodological significance of this study for WMD forecasting is its emphasis on the critical importance of political factors that work to shape proliferation decisions that serve to constrain the spread of nuclear weapons. In another collective judgment study using individual authors, Rebecca Hersman makes the point on the importance of political factors in her chapter differently – that "rollback" in a proliferator state like Taiwan or South Korea "*is a process*, not an outcome or state of being."[3] The current political intent could change, and go back into a proliferation gear. Taiwan and South Korea are regarded as likely backsliders if a tipping point is reached.

Another collective judgment study, *Mapping the Global Future – Report of NIC's 2020 Project*, also addresses larger questions, aided by the use of a large array of participants in various phases of the project. Its focus was on globalization and the drivers of geopolitical changes, with WMD threats only one of several concerns. The depicted geopolitical trends and changes are a useful contextual backdrop for political and military analysis of the impact of proliferation outbreaks on regional security dynamics. This study also utilized the alternative futures or scenarios methodology to enrich and presumably to test specific forecasts in the workshops that were held. It dedicated one scenario entitled *A New Caliphate* to sharpen understandings of future challenges to governance from Islamic political forces, and another entitled *Cycle of Fear* to illuminate potential WMD dangers and set its WMD forecasts in a more evocative context.

Most of the assessed studies shared similar judgments about the prospects of non-state actors, especially terrorists, gaining access to or using WMD. None of the studies offered a unique methodology for dealing with this subject. None of the assessed studies dealt exclusively with terrorists, either. While forecasts in this area of WMD and terrorism were

[3] Rebecca K.C. Hersman and Robert Peters, "Nuclear U-Turns: Learning from South Korean and Taiwanese Rollback," in *Nuclear Weapons Proliferation: 2016* (see bibliography for full citation), pp. 539-554.

fairly general, they tended to converge on the expectation that terrorist attacks using WMD would eventually occur, and probably in the near future. The forecasts did not assign relative probabilities to terrorist use of N, B, or C, or even RDD. Some studies did expect that innovation would characterize terrorist attacks, but also that these might just as easily use conventional explosives or take advantage, as the 9/11 attackers did with fully fueled passenger aircraft, of the built-in destructive potential in the surroundings.

Yet another use of collective judgment, by the *Air Force Futures Project: Emerging WMD Technologies* study, was to structure and extract from a highly-expert debate about hypothetical WMD outcomes of technological evolution. Panels of experts in relevant technologies were enlisted and pressed to agree or disagree on whether expected future developments in cyber-technology, nanotechnology, and advanced energy-release technologies would be realized, what these developments would consist of, and whether their use could produce new types or new kinds of WMD. This led to a clearer understanding of the boundaries between weapons of mass disruption and of true mass destruction, and between enablers of WMD and true WMD. This gave the authors an opportunity to reach their own conclusions on how to classify potential new weapons and to discuss the practical advisability of expanding the definition of WMD. In summarizing their results, the authors were also able to portray how certain new technologies and modes of utilization could present foreseeable challenges to the Air Force, and also how some of them could be used by the Air Force itself.

The two quantitative studies of nuclear proliferation by academic authors, *Correlates of Nuclear Proliferation* (2004) and *Determinants of Nuclear Weapons Proliferation* (2007), were not designed to be forecasts of the future status of nuclear proliferation around the world. Rather, their purpose was to use rigorous quantitative methods to drill down in uniformly structured "country" data sets, collected in time series on the past, to determine which variables best explained relevant state-level decisions to proliferate, hedge, or abstain. To the extent the explanatory variables could be shown to be powerful, the presumption was that they could have forecasting utility for the future, using updated data. These studies generally found that the best traditional analysis of proliferation motivations – particularly on security variables – was already on the mark, or close to it, and that their own findings in that respect added nothing dramatically new or different. Still, they contained a few minor surprises that could be food for thought, either in critiquing the quantitative methods and data they used or in interpreting or improving on traditional proliferation analyses. The *Determinants* study's findings, for instance, suggested counter-intuitively that states already facing nuclear-armed rivals are more likely to desist than proliferate. More plausibly, this study also found that democratic states are less likely to proliferate if they do not already have a nuclear weapons program, and more likely to proliferate if they already have such a program. It found the strongest driver of nuclear proliferation to be the rise of an external *conventional* military threat, the thrust of which few experts would disagree with.

The two studies in this particular sample of statistically oriented quantitative studies were quite ingenious in their definitions, variables, and use of regression, but disappointing in

their paucity of novel findings. Statistical analysis of country data of the past to model the future probably is going to be only as good as the data collected and the meaningfulness of the variables specified. This type of statistical analysis may be useful for heuristic purposes in thinking about future motivations and drivers, but is unlikely to be a reliable means of forecasting real world proliferation. Other quantitative data analysis methods and data sets, such as content analysis of national statements and media reports, or public opinion survey data, may prove useful to WMD forecasting but were not represented and are not evaluated here.

Generating Key Questions

A relatively small number of the studies used methodologies that were suitable for framing innovative or unconventional questions about the future of WMD proliferation and potential use of WMD. Estimative intelligence, trend analysis, and technological extrapolation face natural limits in forecasting how proliferation conditions and the challenges they could pose may change unexpectedly. It can be highly useful to use intelligent types of conjecture, thoughtfully structured scenarios, and other stimuli to imagination to envision alternative futures. Out of the box thinking can be ignited by a serendipitous leap of imagination but it can also be elicited in well-led structured exercises.

In the same vein, state decision-making and interaction patterns on WMD could also be modeled to project reactions to newly introduced conditions – a kind of futures methodology unrepresented in our sample. Modeling methodologies would not necessarily produce real world WMD forecasts, but could, in principle, go a long way to define and test contingent forecasts, such as hypotheses on how certain states of concern might react to a hostile use of WMD on a vital target on their territories, or to nuclear explosive testing by a neighbor. Examining those models and their results could be valuable for sensitivity training of analysts and efforts to forecast future developments.

Three of the assessed studies were particularly fertile in reciting or eliciting imaginative thought about the future of WMD, and represent methodologies that are suitable for generating key questions about how the WMD proliferation terrain or WMD weaponry may change. A fourth study that focused narrowly on how a conflict in the Middle East involving BW use might evolve was also well configured to pose key questions about WMD use that have not been settled. Consider each in turn.

Perhaps the most imaginative of all in the sample of studies assessed, *The Changing Face of Proliferation: Thoughts, Speculations, and Provocations* (2005), raised key questions about the future of WMD proliferation in four areas: What would be a suitable way to denominate WMD actors – state and non-state -- to reflect their motivations and character on the emerging proliferation stage, incidentally moving beyond the overly simple "rogue state" terminology? What might actors from each denomination do with WMD? How may transnational opportunities alter WMD acquisition and production structures? And how might the next

WMD use – especially a first nuclear use by a state since 1945 -- affect the future decisions of WMD proliferators and of the anti-proliferation community? This study invents new captions for the types of actors on the proliferation stage, distilling WMD-related motives and geopolitical tendencies.. At the state level they comprise the Reformed Proliferators, the Status Seekers, the Tough-Minded Independents, the Reluctant Non-Proliferators, the Newly Threatened Good Guys, the New Global Powers, Not the Last and Not the Least, and the Renunciationists. Likewise, the non-state characters include Islamist Revivalist-Restorationists, the Islamic Freelancers, Apocalyptic Movements, National Liberationists-Rebels, Home Grown Extremists, Criminal Organizations, and Coup-Makers. The study goes on to speculate about how these actors might behave with WMD under prospective conditions, how best to characterize the challenges they will present, and how to visualize responses to actual WMD use that could shape the environment in desirable ways. This essay is a model of how to elicit a deeper understanding of what the WMD future may look like, and how to stimulate creative thinking about response.

A second unusually fertile study in eliciting unconventional ways to visualize the WMD future is *Thwarting an 'Evil Genius'* (2006), already commented on at some length in the section above on "Wild Cards and Potentials for Surprise." This study is narrowly structured to anticipate near-term threats to the homeland and includes but is not restricted to WMD technologies. Its methodology of setting participants loose to simulate how an "evil genius" using current technology could do the most damage to American self-confidence, social cohesion, and political culture produced unusually insightful results. The scenarios are well designed to challenge and expand the thinking of those who have the responsibility for planning and executing response.

The third study that is methodologically designed to stimulate imaginative inquiry is the *Air Force Futures Project* (2007), focused on future WMD technologies, particularly the physical. This study has also been commented on earlier. Part of its virtue is to expand the understanding of future potential forms of WMD and conceivable employment mechanisms. By doing so, it forces creative thought about response. Its methodological use of expert interviews on the evolution of new technologies also led to a key question about the adequacy of the present definition of WMD and a tentative implication for policy that retaining the present definition may be prudent, at least for the time being.

The fourth study to merit attention here as a generator of key questions is *Prospects of Biological War in the Middle East* (2002). The central question this study addressed was: How likely is the use of BW by a regional state against the United States or its allies, and what form could that WMD use take in the event of another serious conflict in the Middle East? There are a number of historical cases of CW use in the Middle East since World War II, but no known cases so far of BW use in a military conflict. The presumption has been that state use of BW against the United States has been deterred (e.g., in Iraq under Saddam Hussein, in 1991 and 2003), and will be deterred again if needed. But the reliability of this deterrence

proposition against WMD-armed regional powers has become increasingly controversial. This study walks through the calculus of a hostile BW-armed regional power at various stages in a conflict in which the United States intervenes, to show that it is plausible to anticipate BW use by the regional power under certain circumstances, which the study dissects methodically. This study models the kind of contingency analysis of BW military use at one or another stage of a live conflict that U.S. military planners will have to apply to every BW-armed regional power that emerges when U.S. intervention in its neighborhood is plausible.

How Have WMD Forecasts Changed Since 9/11?

WMD forecasts since the terrorist attacks on the United States on September 11, 2001 have changed in significant ways. Those studies in our sample that were published after 9/11 generally show:

- Greater awareness of and more emphasis in analysis on the potential for future spectacular terrorist threats to the homeland;
- Greater acceptance of the credibility of terrorist acquisition of WMD, and of the likelihood of terrorist use of WMD inside the United States and Western countries generally; and
- Elevation of terrorist WMD threats to "strategic status," at least in U.S. intelligence statements and in the analytical work on WMD sponsored directly or indirectly by the U.S. Government.

Not surprisingly, most of the new emphasis on terrorism focused on al-Qaeda and other Islamic extremist groups. However, the more disciplined studies also included references to Aum Shinrikyo, secular terrorists, and home-grown terrorists. No forecasts attempt to measure the probability of WMD terrorist attacks succeeding in their objectives, or failing. On choices of methodology for analysis and forecasting, there were no obvious differences between studies in the sample prepared before 9/11 and those prepared later.

Section V: Contemporary Assessments – Synopses

Executive Summary of Report of Rumsfeld Commission to Assess the Ballistic Missile Threat to the United States

In Rumsfeld Commission, *Washington, D.C.*
U.S. Congress, 1998

Overview
The 307-page full Report of the Commission is classified and accompanied by two classified appendices, as well as an unclassified Appendix III of working papers. This assessment is of the unclassified Executive Summary only.

Commissioned By
U.S. Congress, pursuant to National Defense Authorization Act for Fiscal Year 1997, PL 104-201, Section 1321(g).

Purpose and Objectives
To assess the nature and magnitude of the existing and emerging ballistic missile threat to the United States. The ballistic missile threats examined by the Commission included those deployed on the territory of potentially hostile states; those that could be launched from a surface vessel or submarine operating off the U.S. coasts, or from an aircraft; and, those deployed by a potentially hostile nation on the territory of a third party to reduce the range required to strike the United States. The Commission examined the potential of existing and emerging powers to arm ballistic missiles with weapons of mass destruction (WMD), including nuclear, biological, and chemical weapons (NBC). The Commission noted but excluded examination of the cruise missile threat and excluded assessment of the impact of the ballistic missile threat on U.S. military strategy and doctrine or U.S. policy issues associated with response to the threat.

Timeframe Examined
The Commission did not specify a future time-frame for its assessment, but made forecasting judgments looking out 5, 10, 15 or more years, varying implicitly according to the information available about the ballistic missile and WMD capabilities and infrastructure or behavior of each assessed country and the trends in diffusion of technology.

Prevailing Context
The domestic context for the study was controversy in the U.S. Congress and policy community circa 1997 about growing international ballistic missile and WMD threats and dissatisfaction surrounding the absence of construction of a U.S. strategic defense shield

against ballistic missiles. The study also stemmed from dissatisfaction over perceived limitations of earlier National Intelligence Estimates (NIEs) in projecting – with sufficient warning time – long-range and unconventional ballistic missile threats to U.S. territory and to U.S. interests overseas. Additionally, there were many international factors driving the study. Concerns at the strategic level included Russia's reported retention of biological warfare capabilities and revival of Russian policies that implied nuclear response to conventional war, and growing Chinese prowess with space systems. Concerns about the infrastructure for nuclear, chemical and biological weapons programs and stockpiling had been accentuated by the use of CW in the Iran-Iraq war and the results of international inspections of missile and WMD programs in Iraq after the first Gulf War. More immediately pressing was wider proliferation of ballistic missile capabilities and acceleration of the North Korean and Iranian ballistic missile programs to develop long-range ballistic missiles with prospective ICBM and WMD payload capability.

Methodology

The methodology was ultimately the use of a senior and experienced panel to extract and formulate qualitative propositions about prospective or projected ballistic missile and WMD threats. It aimed to access a wide range of opinion and the greatest possible depth and breadth of analysis. In comparison with earlier IC estimates, the Commission's findings diverge due to "use of a somewhat more comprehensive methodology in assessing ballistic missile development and deployment programs." This approach, unique at the time for estimative intelligence, took fuller "account of three crucial factors shaping new ballistic missile threats to the United States":

- Newer ballistic missile and WMD development programs do not follow the patterns and the high standards of U.S. and former Soviet programs with respect to missile accuracy, reliability, and safety, nor produce large numbers of missiles, and therefore can deploy more rapidly (or with shorter warning).
- Nations currently attempting to develop ballistic missiles and WMD can avail themselves of technical assistance from outside sources (shortening time frames to deployment).
- Nations developing ballistic missiles and WMD can now conceal important elements of their programs and are highly motivated to do so (reducing timely warning).

Executive Summary Format

I. Charter and Organization
II. Executive Summary:
    A. Conclusions of the Commissioners
    B. The Commission and its Methods
    C. New Threats in a Transformed Security Environment
        1. Geopolitical change and role for ballistic missiles
        2. Russia
        3. China

4. Countries with Scud-based missile infrastructures
   a. North Korea
   b. Iran
   c. Iraq
5. India
6. Pakistan

D. A New Nonproliferation Environment
1. Increased competence and trade among emerging ballistic missile powers
2. United States as a contributor to proliferation
3. Motives of countries of concern
4. Readier market access to technology
5. Availability of classified information and export-controlled technology

E. Alternative Ballistic Missile Launch Modes
F. Erosion of Warning
G. Methodology
H. Summary

Key Projections/Forecasts

Motivations to acquire

Some countries with regional ambitions oppose the U.S. role as a stabilizing power in their regions and see the acquisition of missile and WMD technology as a means of restricting U.S. capability to project power or influence in those regions. Since the Cold War, the geopolitical environment and the roles of ballistic missiles and WMD have evolved. Ballistic missiles provide a cost-effective delivery system for both conventional and non-conventional weapons. Nations seeking to block the projection of U.S. power will combine ballistic missiles with WMD in the belief these can provide a strategic counter to U.S. conventional and information-based military superiority.

Regions/countries of greatest concern

The countries of greatest concern include: Russia, China, North Korea, Iran, Iraq, India and Pakistan. (The summary mentions that Syria and Libya are also addressed as countries of concern, but detailed information about these nations is only found in the classified report.)

Specific weapon types (N, B, C, R, and Delivery Means), to include new or non-traditional weapons/effects/production techniques/delivery means

The Commission was concerned primarily with NBC forms of WMD and with their delivery by ballistic missiles, particularly long-range ballistic missiles. The unclassified summary suggests that the Commission was also concerned about the proliferation of cruise missiles but more directly concerned with ballistic missiles as delivery systems, and did not address other forms of delivery.

Acquisition patterns/trends

The assessment generally highlights the widespread availability of ballistic missile technologies from a variety of suppliers on a commercial or closely-held government-to-government basis as a fact, in contrast to the past when export controls may have made a difference. These available technologies include: Scud infrastructure and scaled-up versions of the Scud missile; the reported availability of former Soviet SS-4 solid-fuel MRBM technology; solid-fuel missiles produced for export by China; Indian exploitation of U.S.-origin Scout rocket technology; reported Russian cooperation with India on SLBM technology; and the availability of various West European rocket technologies and components. Acquisition patterns, primary suppliers, and trends are described for recipient countries case by case rather than as a global system. These patterns and trends are projected to continue and possibly to diversify.

Deterrence and employment concepts

Emerging powers see ballistic missiles equipped with WMD as highly effective deterrent weapons and as a means of coercing or intimidating adversaries, including the United States. Such weapons can pose a serious threat to the United States, to its forward-based forces and their staging areas, and to U.S. friends and allies. The projection is that this perspective on hampering U.S. projection of power and influence will intensify.

Areas for potential surprise

The key area for "surprise" in the Commission's assessments is not of the sudden shift in a country toward proliferation or the materialization of a WMD weapon system of unfamiliar type but rather the general problem of eroding and shortening of warning time between the decision to acquire and the effective deployment of a threatening WMD-equipped ballistic missile system by a hostile emerging power. This is due in the case of contemporary emerging powers to their typically low standards for proof and testing of systems in development and the small number of units produced or procured to deploy a threat, as well as to their capability and determination to conceal these systems.

Specific assessments with implicit or conditional forecasts (assumes trends will continue and are accelerating)

Russia

The country is in a precarious transition that could lead either to democracy and stability or to a resurgent nationalism. The number of deployed Russian missiles will drop, but Russia will modernize and deploy more capable – if fewer – systems. If Russia further deteriorates internally, the risk of an accident or loss of control over its missile forces could increase sharply and with little warning. Russian export of enabling technologies to countries hostile to the United States will continue to be a problem, as exemplified in Russia's assistance to Iran, an action that is perceived to have greatly accelerated Iran's ballistic missile program.

China

China's future is also subject to a range of uncertainties. The U.S. and China are developing a more cooperative relationship but significant potential conflicts remain, with China less constrained by fear of Russia than in the past. Taiwan is an obvious flashpoint. Chinese missile deployments and test firings opposite Taiwan show a confrontational tendency. Like Russia, China poses a threat to the United States as a proliferator of ballistic missiles, WMD and enabling technologies. These transfers are unlikely to cease.

North Korea

The nation is working hard on the Taepo Dong 2 (TD-2) ballistic missile. Once the system is assessed to be ready, a test flight could be conducted within six months. If North Korea considers the test successful, the TD-2 could be deployed rapidly, and the United States may have very little warning. North Korea has developed and deployed the No Dong, a MRBM using a scaled-up Scud engine capable of flying 1,300 km. North Korea tested the No Dong only once before deploying it and deployment occurred long before the United States recognized the fact. North Korea also poses a major threat as a proliferator of its ballistic missiles and related support equipment to countries of concern, including Iran and Pakistan. North Korea has an active WMD program, possibly has separated fissile material for one or two nuclear weapons, possesses biological weapons production and dispensing technology, and the capability to deploy CW or BW warheads on missiles.

Iran

Iran is placing great emphasis on its ballistic missile and WMD programs. Its ballistic missile infrastructure is now more advanced than North Korea's, having benefited from extensive Russian and some Chinese assistance. Iran's Shahab-3 MRBM, like the No Dong, has a range of 1,300 km. It could be flight tested at any time and be deployed soon after. Iran has the technical capability to demonstrate an ICBM-range ballistic missile, similar to the TD-2, within 5 years of a decision to proceed. Iran has also acquired and is seeking advanced missile components (e.g., the RD-214 engine which powered the Russian SS-4 MRBM) that can be combined to produce ballistic missiles with sufficient range to strike the United States. Iran is developing WMD. It has a nuclear energy and weapons program with aims to design, develop and produce nuclear weapons. The main uncertainty at present is whether Iran has enough fissile material to produce a weapon. Because of gaps in knowledge, the U.S. is unlikely to know whether Iran possesses nuclear weapons until after the fact. Iran's civil nuclear program is under IAEA safeguards, but it could be used as a source of sufficient fissile material to construct a small number of weapons within the next ten years, if Iran is willing to violate safeguards. If Iran could accumulate enough fissile material from foreign sources, it might be able to develop a nuclear weapon in only one to three years. Iran also has an active CW development and production program, and is conducting research into biological weapons.

Iraq

The nation has maintained the skills and industrial capabilities to reconstitute its long-range ballistic missile program, though its plant and equipment are less developed than those of North Korea or Iran as a result of actions forced by UN Resolutions and monitoring. If UN-imposed controls are lifted, Iraq could mount a determined effort to acquired plant and equipment and could pose an ICBM threat to the United States within 10 years. Prior to invading Kuwait, Iraq could have had nuclear weapons in the 1993-1995 timeframe. Iraq has the capability to reconstitute its nuclear weapon program, with the speed of reconstitution depending on availability of fissile material. It would take several years to build the required production facilities from scratch. Iraq also had large CW and BW programs before the war and produced CW and BW warheads for its missiles. It could reconstitute these programs rapidly following the lifting of sanctions.

India

India is developing a variety of ballistic missiles with short to medium and long ranges, and ship-launched missiles including a SLBM. Both liquid and solid-fueled types are in development. India's space launch program now provides an ICBM option. India tested several nuclear devices and is developing warheads for its missile systems. India also has biological and chemical weapons programs. India has acquired and continues to seek Russian, U.S. and Western European technology for its missile programs. Russian assistance has accelerated India's missile development and sophistication, and is critical to India's development of a SLBM and related submarine platform. India's industrial base is diversified, and it is in a position to become a supplier of missile technology. Supplier control regimes could affect only the rate of acceleration of India's programs.

Pakistan

The country has a more advanced missile infrastructure than North Korea, and can support development of a 2,500 km range missile. Success will give Pakistan the technical base for developing a much longer range missile system. Through foreign acquisition, Pakistan acquired its capabilities quite rapidly. China and North Korea have been Pakistan's primary sources of ballistic missiles, production facilities, and technology. Pakistan has tested nuclear weapons based on highly enriched uranium and has also built a nuclear reactor that could be used to produce plutonium. In addition to nuclear weapons, Pakistan has biological and chemical weapons programs. Chinese assistance has been crucial to Pakistan's nuclear weapons program.

India and Pakistan are not hostile to the United States. Hence the prospect of U.S. military confrontation with either seems slight. But the possibility of nuclear war on the subcontinent and the nations' aggressive development of ballistic missiles and WMD pose three concerns: 1) it enables them to supply relevant technologies to other nations; 2) they may seek additional technical assistance from their current major suppliers; 3) their growing missile and WMD capabilities have direct effects on U.S. regional and global policies, and could affect U.S. capability to play a stabilizing role in Asia.

Emerging Missile Powers

A new strategic environment now gives the emerging ballistic missile powers the capacity, through domestic development and foreign assistance, to acquire the means to strike the U.S. within about five years of the decision to acquire such a capability.

Significant Points

- Changes in the strategic environment have expanded the range of available ballistic missile technologies and enabled the acceleration of ballistic missile development programs.
- This coupled with emerging missile powers adopting a different model of development and testing, with few tests and low production levels, and sophisticated denial and deception, means that the warning time the intelligence community once took for granted has drastically eroded.
- New methods of intelligence assessment are required to evaluate the levels of achievement and rate of progress in such programs.
- Several of the programs of emerging missile powers have actual or inherent ICBM capabilities underway.
- Potential options of emerging missile powers to launch from other countries closer to their targets, and sea-launch options close to U.S. shores, need to be taken into account in ballistic missile assessments.

Other Major Conclusions and Unique Dimensions

The unique aspects of the Rumsfeld Commission's study were threefold, first to challenge the methods and results of the IC on inadequacies in its assessments of the rates and patterns of ballistic missile development globally, second, to demonstrate an expanded methodology that assesses the patterns of supply and technology diffusion in estimating the capacities and rates of development in emerging missile powers, and third, to warn of the immediacy of the encroaching strategic threat from emerging missile powers' growing capacity to strike the United States directly with WMD-equipped ballistic missiles.

Conclusions

Most of the major conclusions of the Executive Summary are given above under Significant Points. The Commission further recommended that U.S. analyses, practices, and policies that depend on expectations of extended warning of deployment of ballistic missiles be reviewed and, as appropriate, revised to reflect the reality of an environment in which there may be little or no warning.

Tracking Nuclear Proliferation, a Guide in Maps and Charts

Rodney Jones
Carnegie, 1998

Commissioned By

Carnegie Endowment for International Peace, as one of its own study projects and publications for public education and substantive relevance to national and international security policy and the furtherance of peace, supported by funding from several private foundations.

Purpose and Objectives

The purpose of this book was to provide the most complete and authoritative resource available from open sources on the spread of nuclear weapons and their means of delivery as well as an account of successful nuclear arms reduction and dismantlement in the former Soviet states. *Tracking Nuclear Proliferation* compiles and evaluates technical and political developments in the nuclear programs and capabilities of the selected countries with detailed open-source reference information on nuclear facilities, technology, materials, and sites in countries of concern. While the main focus is nuclear, the country chapters also weave in information on other known or suspected WMD capabilities and programs, and a separate chapter is devoted to country-specific developments in missile proliferation. The objectives of the study were: to increase public knowledge and attention to nuclear proliferation trends; provide broad support to public policies and arrangements designed to prevent, arrest or control proliferation; and to make available in one place a detailed and objective reference work for the use of scholars, experts, think tanks and even public officials. With a broad scope, the work contains appendices on the NPT and the results of NPT review conferences, the CTBT, IAEA safeguards, nuclear weapon-free zones, Nuclear Supplier organizations and export controls, and the MTCR and Wassenaar Arrangement.

Timeframe Examined

1995-2000. The study contains limited proliferation forecasts based on acquisition trend analysis looking to the near future.

Prevailing Context

The prevailing context at the time was the general glow of the end of the Cold War and expansion of arms control arrangements (particularly the INF and START Treaties), with the expectation that more effective progress would be made to stop nuclear, missile and WMD proliferation. The book emphasized the rising challenges of proliferation.

Methodology

Methodology used was a classical policy-oriented compilation of technical, political and economic data from open sources and qualitative analysis by non-government experts based on an understanding of the technical aspects of nuclear proliferation, trends in technology

acquisition or development, and preventative measures ranging from the NPT and IAEA, export controls, and safeguards to diplomatic intervention. The in-house study team had considerable expertise on the history of the nonproliferation regime, the special issues of dealing with strategic arms control and the former Soviet Union, and the technical and political developments related to nuclear and missile proliferation in key regions and the reference countries. The study team occasionally solicited outside regional or country expertise, as needed, and obtained reviews of work in progress by other experts.

Report Format

With a broad scope, the work offered an overview of proliferation trends, new challenges, and the proliferation status at the time of potential suppliers and aspiring countries with nuclear and missile development programs. The main body tracked proliferation developments in specific regions and countries of concern. The countries selected for proliferation tracking analysis include Russia and China as classical nuclear weapon states and potential suppliers; the denuclearized post-Soviet states of Ukraine, Belarus, and Kazakhstan; and the other countries then considered to be of proliferation concern grouped by geographic region: Romania in Eastern Europe; India, Pakistan and North Korea in South and East Asia; Algeria, Iran, Iraq, Israel, and Libya in the Middle East; Brazil and Argentina in Latin America; and South Africa in sub-Saharan Africa. A chapter is devoted to each of the seventeen selected countries, together with appendices displaying tabular information on nuclear capabilities and a map of known nuclear facilities and sites. The larger study also contains a series of appendices on the NPT and the results of review conferences, the CTBT, IAEA safeguards, nuclear weapon-free zones, Nuclear Supplier organizations and export controls, and the MTCR and Wassenaar Arrangement.

Key Projections/Forecasts

Motivations to acquire

The authors projected that increased international security due to US-Soviet strategic nuclear reductions, the end of the Cold War and the denuclearization of the former Soviet Union (FSU) states could reduce global proliferation pressures, and they suggested this would be most salient in the advanced countries – especially in NATO, Japan, Brazil, Argentina, and South Africa. Elsewhere, particularly in certain parts of the Middle East, South Asia and the Korean peninsula, the tracking analysis indicated that motives for acquiring nuclear weapons and missile delivery were growing stronger, and that the 1998 nuclear tests in India and Pakistan were not only bound to aggravate arms competition in the subcontinent but also likely to increase regional proliferation pressures, particularly in the Persian Gulf region, and to pose unprecedented challenges to the nuclear non-nonproliferation regime and the missile technology control regime (MTCR). The authors described the dangers of weapons or fissile material diversion from Russia and tracked U.S. cooperative threat reduction (CTR) efforts to neutralize those threats. The tracking analysis recorded the history of chemical weapon acquisitions in Iraq and Iran and the suspected presence in North Korea.

Regions/countries of greatest concern

The regions and countries of greatest concern were reflected in the country chapters: Russia and China as potential suppliers, India and Pakistan as newly declared nuclear powers, North Korea with a covert nuclear capability and as a missile technology exporter, Iran and Iraq as likely proliferants, Israel as an undeclared nuclear power, Algeria and Libya as aspiring states, and Romania as a suspect ex-Warsaw Pact state with past clandestine acquisition. The study did not foresee that Libyan efforts to develop nuclear and WMD programs could be totally reversed.

Specific weapon types (N, B, C, R, delivery means), to include new or non-traditional weapons/effects/production techniques/delivery means

This study focused primarily on nuclear weapon programs and secondarily on missile delivery systems. It wove in reports of chemical weapons capability in certain country reports, but did not assess chemical or biological weapons programs systematically. A separate chapter was devoted to Missile Proliferation and the objectives of the MTCR. The data in this chapter extended beyond the 17 countries addressed in separate chapters. It dealt primarily with legacy delivery systems (e.g., SCUD missiles and derivatives, Silkworm-type cruise missiles, and export versions of Chinese solid-fuel ballistic missiles) that had been acquired by countries in North Africa, the Middle East and Asia. The Chart listing countries possessing ballistic missiles and their origins contains 30 possessing countries, not including Russia and China, although they are frequently noted in the column of suppliers. This compilation of missile data, however, was not employed to project nuclear military postures or force structures of emerging nuclear powers or proliferant states, nor was it oriented to assessing futuristic delivery system or special weapons effect technologies or to Russian or Chinese strategic challenges to U.S. military power. These subjects were outside the scope and objectives of this work.

Acquisition patterns/trends

This study assembled fairly detailed information on nuclear and missile acquisition patterns and trends in proliferant countries, and, where relevant, the nuclear and missile supplier behavior of the countries studied. Since the study focused on countries of proliferation concern and not on the advanced industrial countries of the free world, it did not attempt to develop a comprehensive picture of nuclear or chemical supplier behavior relevant to proliferation. The cross-section of missile development in the study was reasonably accurate for its time and holds up well ten years later.

Deterrence and employment concepts

This study made no systematic effort to assess or project the likely military posture, planning, employment policies or doctrines of emerging nuclear powers or potential nuclear proliferant states, or of other WMD capabilities in their inventories.

Areas for potential surprise

The projections in this study were primarily forecasts of further acquisition of sensitive technologies and nuclear capability by a selected set of countries of concern. To date, with the possible exception of Syria, no other countries have come to notice as likely nuclear proliferation candidates. This study reflected concerns about the danger of leakage of nuclear materials to terrorists, but was focused on acquisition patterns of countries of concern rather than on potential proliferation to non-state actors or terrorist organizations. The projections in the study took into account the existence of a nuclear black market and the history of A. Q. Khan's role in using centrifuge technology from Europe to develop uranium enrichment programs in Pakistan but did not specifically forecast his network as a supplier to other proliferant countries.

Specific forecasts

- Post-Cold War Russian nuclear export behavior would pose certain export-driven challenges to the nonproliferation regime, particularly in Iran and India, possibly Iraq (then under UN sanctions and inspection activities), and possibly North Korea. In retrospect, it appears Russia has, however, distanced itself from North Korea.

- China's cooperation with the main thrust of the nonproliferation regime had improved, and was likely to improve further – conforming to NSG and MTCR guidelines. It subsequently became a member of the NSG. Despite lingering questions, this forecast appears to be valid, and is currently reflected in China's leadership in the Six-Nation Talks with North Korea.

- Korea's nuclear weapon ambitions were real but with uncertainty as to its success in making technical breakthroughs in operational weapons capability as well as on whether the Agreed Framework would hold. In retrospect, it did not, but the current Six Nation Talks are similar in inducement-based approaches, seeking to use material and political incentives to convince Pyongyang to freeze and disassemble nuclear facilities and any weapons it may have stockpiled.

- The 1998 nuclear tests in India and Pakistan would cause a more vigorous conventional arms competition locally, a buildup of nuclear-capable delivery systems on both sides, and probably stimulate deployment and elaboration of command and control and early warning systems. The study noted India's effort to develop nuclear-powered submarines as missile platforms. These forecasts were largely on track although keeping most weapons in storage and evidently unassembled, together with reticence in deploying combat-ready systems on alert, was not directly anticipated and contrasts with most U.S. and Soviet practice during the Cold War.

- Iran would likely achieve sensitive nuclear technologies and potential breakout capability but in a more distant future than seems possible from recent disclosures of its goals for uranium enrichment capacity.

- Russia and FSU states would cooperate more unequivocally in rapid dismantlement of Cold War nuclear and chemical capabilities than has proved to be the case. The denuclearization of Ukraine was successful, and the reductions and dismantlement of delivery systems called for under INF and START I has been largely implemented. But dismantlement has lagged in areas not covered by treaties, e.g., tactical nuclear warheads.

- Russia would be ambivalent in strict application of NSG guidelines was forecast realistically.

- The United States would press hard for restraint in South Asia; this projection did not foresee U.S. courtship of India as a strategic partner and willingness to cooperate with India on civil nuclear affairs.

Other Major Conclusions and Unique Dimensions

The most unique dimensions of this study are in the thoroughness of its system for compiling, tracking, and displaying the types and size of nuclear capabilities, materials, and programs in countries of concern from open source information. With the end of the Cold War as a backdrop, it was, in addition, important in enlarging the scope of proliferation analysis to track FSU nuclear facilities and materials, with a view to strengthening internal and nonproliferation controls and indirectly supporting Congressionally-funded threat reduction and dismantlement programs in the FSU region. Officials in service in nonproliferation related offices found this study to be a most useful reference as to what information was already in the public domain on nuclear matters, country by country, and that could be discussed, therefore, with private experts and ordinary citizens on an unclassified basis. Researchers without the specialized knowledge on proliferation found this a really useful volume to read up on the subject, or on countries of concern.

Conclusions

Tracking Nuclear Proliferation was not designed as a systematic or explicit forecast of all WMD proliferation or even of nuclear proliferation, but it nevertheless provided a detailed compilation and analysis of global nuclear proliferation trends based on an appropriate level of policy-relevant understanding of nuclear technology and nuclear-capable delivery systems. Those depicted trends were a sound basis for estimative judgments or extrapolations about the pace and scope of proliferation in the regions and countries of concern, and have stood up quite well since. It also provided a compilation of legacy missile technology spread in countries of concern that was a useful reference source as well as basis for estimating trends. One should also consider the list of specific forecasts above to be conclusions of this work.

Its main objective was to enlarge understanding of the threat of proliferation, particularly nuclear, and to encourage preventative efforts across the policy spectrum.

Living Nightmares: Biological Threats Enabled by Molecular Biology

Steven Block, edited by S.D. Drell, A.D. Sofaer and G.D. Wilson
In The New Terror: Facing the Threat of Biological and Chemical Weapons.
Stanford: Hoover Institution Press, 1999

Commissioned By
Steven Block's article draws on the his experience in leading the JASONS Group's 1997 Summer Study which assessed work at the forefront of the life sciences (biology), specifically the threat posed by the development and use of biological agents.

Purpose and Objectives
To determine the future of biological warfare based on how recent advances in the life sciences (especially the potential for genetically engineered pathogens) have changed the nature and scope of that threat.

Timeframe Examined
Study was performed in 1997, and looks into 21st century, but without a specific timeframe.

Prevailing Context
Dissemination of the JASON's summer study was spurred by the publication of Richard Preston's, *The Cobra Event*, in 1997 – a popular novel on bioterrorism. President Clinton read the book and asked about the issues. A 1997 issue of the Journal of the American Medical Association (JAMA) was published on biological warfare, and a surge of media interest peaked in 1997 and 1998 in the potential for BW attacks. Two Presidential Directives, PDDs 62 and 63, on CBW and cyber threats, were being prepared.

Methodology
The 1997 JASON summer study aimed to identify avenues of future development for biological warfare (BW) agents. It was an opportunity to assess the strengths and weaknesses of bioweaponry currently believed to exist. The study provided an imaginative framework for projecting what might someday come into existence, both through traditional approaches and through recent advances in biotechnology. The study attempted to help the researchers consider the kinds of countermeasures that might be needed to defend populations or minimize the damage of bio-attacks. The essence of the study's forecast is that if it can be done technologically, eventually it will be done. Creating entirely new biological WMD of extraordinary potency has become comparatively easy and cheap, the means have been spread as public knowledge globally, and some BW capabilities would even be accessible to terrorist groups.

Report Format
A. Block's report discusses conventional BW agents (bacterial, viral, toxin, and fungal) and anthrax and its limitations as a bioweapon; the report also generates a list of

attributes that, theoretically, a genetically engineered pathogen could have, transcending the limitations of airborne anthrax. The paper also briefly reviews evidence of Soviet biowarfare programs, including bioengineering of anthrax as a weapon. From this background, he distills biological attributes that could be on a "wish list" of scientists attempting to build more effective bioweapons:

- Safer handling and deployment
- Easier propagation and/or distribution
- Improved ability to target the host
- Greater transmissivity, infectivity
- More difficult to detect
- Greater toxicity, harder to treat or counter (e.g., drug resistant)
- Self-limiting, self-enhancing, or other special features

B. The 1997 JASON summer study arrived at a list of six broad classes of unconventional pathogens that might, or might not, come to pose a threat in the 21st century. Not intended to be all inclusive, the list was meant to convey a sense of the spectrum of possibilities:

Binary BW
Two bacterial substances that are produced separately to be materials that are safe to handle and store, but when combined by a trigger in a reactor, form a lethal agent with antibiotic resistance.

Designer Genes and Life Forms
Carrying out "evolution" in a test tube to produce organisms equipped with antibiotic resistance; or to manufacture synthetic viruses with pre-selected attributes to evade the human immune system, or even combine genes to create a complete organism from scratch.

Gene Therapy as a Weapon
Introduction of genes as vectors in therapy that interact with host physiologically to induce illness rather than curing it.

Stealth Viruses
Using a viral vector that can enter and spread in human cells and remain resident for lengthy periods without producing detectable harm, until triggered by an appropriate external (or internal) signal, when the cryptic virus is activated and causes disease. Stealth virus could be designed to be contagious and spread silently throughout a given population.

Host-Swapping Diseases
Most viruses are symbiotic and depend on the host. As such, they do not cause disease that kills the host (which is akin to suicide for the virus). However, virus mutations and host swaps occur in nature and sometimes a virus that swaps hosts is deadly to the new host. Biotechnology with stringent genetic selection may experimentally transform animal hosted

viruses to produce disease or become lethal when these viruses swap their host to humans – the potential for a man-made emergent disease.

Designer Diseases

With advances in cellular and molecular biology, it is becoming possible to contemplate a disease and then construct a pathogen to produce that disease, using molecular signaling pathways that are critical to human health. Such diseases may target the immune system or instruct cells to commit suicide.

Key Projections/Forecasts

This study's forecast is not specific in relation to countries, regions, or military contexts. It is a generic forecast of scientific and technological capability in biology; specifically, it states that biowarfare agents will be experimented with and developed. If it can be done technologically, eventually it will be done. The study identifies six classes of unconventional pathogens (see previous section), among which real bioweapons may materialize in the future. It does not forecast which classes or which types within classes may be the most likely pools to monitor.

Specific forecasts

This study makes no specific forecasts.

Significant points

This study's significant points are the imaginative projection (hypothesization) of classes of bioweapons capability.

Other Major Conclusions and Unique Dimensions

As part of a growing class of studies on the implications of genetic engineering for bioweapon threats, the study makes a persuasive contribution in raising the level of alert with respect to BW and calling for preparatory actions.

Conclusions

The nature of the forecast – that unprecedented bioweapon capabilities are likely to be invented and produced as a matter of course in the 21st century – set the stage in Block's article for recommendations to the scientific, medical and public policy communities on how to prepare and organize to meet the challenges. These recommendations cover the following challenges in dealing with the next generation of pathogens:

1. Anticipation and Detection
   – Identification and classification
   – Screening
   – Vigilance
2. Mitigation and Remediation
3. Political and Military Response

Foreign Missile Developments and the Ballistic Missile Threat through 2015

In National Intelligence Estimate, Washington, D.C.
National Intelligence Council, 2001

Note

This analysis discusses the Unclassified Summary of a National Intelligence Estimate, December 2001, approved for publication by the Foreign National Intelligence Board under the authority of the Director of Central Intelligence; prepared under the auspices of the National Intelligence Officer for Strategic and Nuclear Programs.

Commissioned By

The NIE was commissioned by the Director of Central Intelligence. The NIE was also the fourth annual report on foreign ballistic missile developments prepared per request of the Senate Select Committee on Intelligence.

Purpose and Objectives

The NIE describes new missile developments and Intelligence Community (IC) projections of possible and likely ballistic missile threats to the United States, U.S. interests overseas, and military forces or allies through 2015. It updates earlier assessments of theater ballistic missile forces worldwide, discusses the evolving proliferation environment, and provides a summary of forward-based threats and cruise missiles. The report covers future ballistic missile capabilities of several countries that have ballistic missiles and ballistic missile development programs. Each country section includes a discussion of theater-range systems and current and projected long-range systems.

Timeframe Examined

2001-2015

Prevailing Context

The underlying NIE in the form of an annual report to the SSCI means that the study would be considered a routine annual assessment of the IC rather than a study precipitated by unusual national or international events or politics. However, it is worth noting that publishing an unclassified version of this assessment came soon after the al-Qaeda terrorist attack on the United States of September 11, 2001. The underlying assessment was done early in the first term of George W. Bush's administration following years of growing congressional interest in ballistic missile defense and particular concerns about emerging missile powers developing ICBM capabilities that could target and deliver WMD payloads to the United States.

Methodology
The development then of an NIE followed estimative assessment methods of intelligence data analysis, along with interaction among appropriate representatives and offices of the relevant intelligence agencies. However, emulating methods used by the Rumsfeld Commission (1998), the IC's NIE methodology on ballistic missile development projections in 1999 and 2001 incorporated data not only on industry models and technical intelligence collected on a host state's testing of particular missiles but also on the nature of supplier relationships of missile technology to better estimate the rate of development in the missile programs of each emerging missile state of concern.

Report Format
The Unclassified Summary of the NIE was organized under the following topics and sections on countries of concern:

- Key Judgments
- Discussion
- Introduction
- Russia
- China
- North Korea
- Iran
- Iraq
- Libya
- Syria
- India
- Pakistan
- Forward-Based Missile Threats to the United States
- Non-missile WMD Threats to the United States

Key Projections/Forecasts

Motivations to acquire

- Non-missile means for delivering WMD do not provide the same prestige, deterrence, and coercive diplomacy as ICBM's provide, but they are less expensive, more reliable and accurate, more effective for disseminating biological warfare agents, can be used without attribution, and would avoid missile defenses.
- The key drivers behind Iraq's ballistic missile program are Baghdad's goal of becoming the predominant regional power and its hostile relations with many of its neighbors.
- Foreign nonstate actors –including terrorist, insurgent, or extremist groups that have threatened or have the ability to attack the United States or its interests–have expressed interest in chemical, biological, radiological, or nuclear (CBRN) materials.
- New Delhi believes that a nuclear-capable missile delivery option is necessary to deter Pakistani first use of nuclear weapons and thereby preserve the option to

wage limited conventional war in response to Pakistani provocations in Kashmir or elsewhere. Nuclear weapons also serve as a hedge against a confrontation with China. New Delhi views the development, not just the possession, of nuclear-capable ballistic missiles as the symbols of a world power and an important component of self-reliance.

- Pakistan sees missile-delivered nuclear weapons as a vital deterrent to India's much larger conventional forces, and as a necessary counter to India's nuclear program. Pakistan pursued a nuclear capability more for strategic reasons than for international prestige.

Regions/countries of greatest concern

- Most of the IC projects that before 2015 the United States most likely will face ICBM threats from North Korea and Iran, and possibly from Iraq (barring significant changes in their political orientations) in addition to the longstanding threat posed by the missile forces of Russia and China. One agency assessed that the United States is unlikely to face an ICBM threat from Iran before 2015.
- UN sanctions have impeded Libyan efforts to obtain foreign assistance for its longer range missile programs. If a missile were offered with range sufficient to strike 2,500 kilometers into Europe, Libya would try to obtain it. Libya lacks the infrastructure required to develop by 2015 a ballistic missile system with sufficient range to target U.S. territory. Libya's paths to obtaining an ICBM during this time frame would probably be to purchase a complete missile system or to set up a foreign assistance arrangement where foreign scientists and technicians design, develop, and produce a missile and the necessary infrastructure in Libya.
- Syria maintains a ballistic missile and rocket force of hundreds of FROG rockets, Scuds, and SS-21 SRBMs. With considerable foreign assistance, Syria progressed to Scud production using primarily locally manufactured parts. Syrian regional concerns may lead Damascus to seek a longer range ballistic missile capability such as North Korea's No Dong MRBM. The IC judges that Syria does not now have and is unlikely to gain an interest in an ICBM capability during the time frame of this Estimate.

Specific weapon types (N, B, C, R, Delivery Means), to include new or non-traditional weapons/effects/production techniques/delivery means

- The worldwide trend in ballistic missile development is toward a maturation process among existing ballistic missile programs rather than toward a large increase in the number of countries possessing ballistic missiles.
- Emerging ballistic missile states continue to increase the range, reliability, and accuracy of the missile systems in their inventories–posing ever greater risks to U.S. forces, interests, and allies throughout the world. A decade ago, U.S. and allied forces abroad faced threats from SRBMs–primarily the Scud and its variants. Today, countries have deployed or are on the verge of deploying MRBMs, placing greater numbers of targets at risk.

- Concerns over the U.S. Missile Defense (MD) program have led high-ranking Russian officials to openly discuss military countermeasures to the system. The SS-27–developed in the 1980s as a response to the Strategic Defense Initiative– is probably the basis for Russia's most credible responses to MD.
- The IC assesses that Iraq retains a small covert force of Scud-variant missiles, launchers, and conventional, chemical, and biological warheads.

Acquisition patterns/trends

- Proliferation of ballistic missile-related technologies, materials, and expertise–especially by Russian, Chinese, and North Korean entities–has enabled emerging missile states to accelerate missile development, acquire new capabilities, and potentially develop even more capable and longer range future systems.
- North Korea is the missile and manufacturing technology source for many programs. North Korean willingness to sell complete systems and components has enabled other states to acquire longer range capabilities earlier than otherwise would have been possible–notably the sale of the No Dong MRBM to Pakistan.
- The North has also helped countries to acquire technologies to serve as the basis for domestic development efforts–as with Iran's reverse-engineering of the No Dong in the Shahab-3 program. Meanwhile, Iran is expanding its efforts to sell missile technology.

Deterrence and employment concepts

- Ballistic missiles were used against U.S. and allied forces during the Gulf war. Although the missiles used in the Gulf war did not have WMD warheads, Iraq had weaponized ballistic missile warheads with BW and CW agents and they were available for use.
- Some of the states armed with missiles have exhibited a willingness to use chemical weapons with other delivery means. In addition, some nonstate entities are seeking chemical, biological, radiological, and nuclear (CBRN) materials and would be willing to use them without missiles. In fact, U.S. territory is more likely to be attacked with these materials from non-missile delivery means–most likely from terrorists–than by missiles, primarily because non-missile delivery means are less costly, easier to acquire, and more reliable and accurate. They also can be used without attribution.
- China's leaders calculate that conventionally armed ballistic missiles add a potent new dimension to Chinese military capabilities, and they are committed to continue fielding them at a rapid pace. Beijing's growing SRBM force provides China with a military capability that avoids the political and practical constraints associated with the use of nuclear-armed missiles. The latest Chinese SRBMs provide a survivable and effective conventional strike force and expand conventional ballistic missile coverage. The IC projects an SRBM force in 2005 of several hundred missiles.

Areas for potential surprise

- Several countries could develop a mechanism to launch SRBMs, MRBMs, or land-attack cruise missiles from forward-based ships or other platforms; a few are likely to do so–more likely for cruise missiles–before 2015.

- The dependence on foreign technology assistance of all emerging missile powers means that their programs could accelerate rapidly if existing restraints on foreign assistance were disregarded by key missile suppliers.

Specific and Contingent Forecasts

- Unless Moscow significantly increases funding for its strategic forces, the Russian arsenal will decline to less than 2,000 warheads by 2015–with or without arms control.
- Chinese ballistic missile forces will increase several-fold by 2015, but Beijing's future ICBM force deployed primarily against the United States – which will number around 75 to 100 warheads – will remain considerably smaller and less capable than the strategic missile forces of Russia and the United States. Beijing is concerned about the survivability of its strategic deterrent against the United States and has a long-running modernization program to develop mobile, solid-propellant ICBMs. The IC projects that by 2015, most of China's strategic missile force will be mobile.
- China could begin deploying the DF-31 solid-fuel, mobile ICBM during the first half of the decade. Beijing could begin deploying the DF-31 follow-on ICBM and JL-2 SLBM in the last half of the decade. China has had the capability to develop and deploy a multiple reentry vehicle system for many years, including a MIRV system. The IC assesses that China could develop a multiple RV system for the liquid-fuel, silo-based CSS-4 ICBM in a few years. Chinese pursuit of a multiple RV capability for its mobile ICBMs and SLBMs would encounter significant technical hurdles and would be costly.
- North Korea's Taepo Dong 2 may be ready for testing but testing may be deferred as long as North Korea holds to its voluntary moratorium on testing of long-range missiles that was extended in May 2001 to 2003. A TD 2 test probably would be conducted in a space-launch mode, in the same way that the TD 1 test was conducted in 1998.
- Iran is pursuing an ICBM/SLV system that the IC agrees it could launch by mid-decade (2005) but also agree that Iran is not likely to flight test before the last half of the decade (2006-2010). One agency believes that Iran is unlikely to conduct a successful test until after 2015. Iranian acquisition of complete systems or major subsystems – such as North Korean TD-2 or Russian engines – could accelerate its capability to flight-test an ICBM/SLV. If Iran were to acquire complete TD2 systems from North Korea, it could conduct a flight test within a year of delivery, allowing time to construct a launch facility. Iran is unlikely to acquire complete ICBM/SLV systems from Russia. If Iran's foreign missile technology assistance

were cut off, it would take Iran much longer to develop an ICBM/SLV system or other missiles still in development.

- The Intelligence Community judges that Iran does not yet have a nuclear weapon. Most agencies assess that Tehran could have one by the end of the decade, although one agency judges it will take longer. All agree that Iran could reduce this time frame by several years with foreign assistance.
- Iraq could test different ICBM concepts before 2015, if UN prohibitions were eliminated in the next few years. Most agencies, however, believe that it is unlikely to do so, even if the prohibitions were eliminated. Some believe that if prohibitions were eliminated Iraq would be likely to test an ICBM masked as an SLV before 2015, possibly before 2010, if it received foreign technology. For the next several years at least, Iraq's ballistic missile initiatives probably will focus on reconstituting its pre-Gulf war capabilities to threaten regional targets and probably will not advance beyond MRBM systems.
- Baghdad had a crash program to develop a nuclear weapon for missile delivery in 1990, but coalition bombing and IAEA and UNSCOM activities significantly set back the effort. The Intelligence Community estimates that Iraq, unconstrained, would take several years to produce enough fissile material to make a weapon.
- The probability that a missile with a WMD will be used against U.S. forces or interests is higher today than during most of the Cold War, and it will continue to grow as the capabilities of potential adversaries mature. More nations have ballistic missiles, and they were used against U.S. and allied forces during the Gulf war. Although the missiles used in the Gulf war did not have WMD warheads, Iraq had weaponized ballistic missile warheads with BW and CW agents and they were available for use.
- Rumors persist surrounding Indian plans for an ICBM program, referred to in open sources as the Surya. Some Indian defense writers argue that possession of an ICBM is a key symbol in India's quest for recognition as a world power. Most components needed for an ICBM are available from India's indigenous space program. India could convert its polar space launch vehicle into an ICBM within a year or two of a decision to do so.

Significant Points

- Certain terrorist groups that have threatened to attack, and are capable of attacking the United States have expressed interest in WMD. These groups are much more likely to use non-missile delivery means to attack the United States or U.S. or allied interests overseas.
- Emerging missile powers are not growing rapidly in numbers but the capabilities of their programs are increasing due to the availability of assistance, particularly from Russia, China, and North Korea. The rate of successful progress in developing ballistic missiles, particularly longer-range ballistic missiles, is heavily influenced by the extent of assistance from supplier sources.

- Inherent ICBM capability in SLV development exists in several emerging missile powers. Nuclear-capable India and North Korea could test such systems early in the decade, Iran probably not until late in the decade at best, and Iraq probably not in the estimate's timeframe – unless UN sanctions were lifted and it obtained significant foreign assistance.

Other Major Conclusions and Unique Dimensions

This unclassified Executive Summary of an NIE was published shortly after the terrorist attacks of September 11, 2001. In accordance with its mandate, this intelligence statement focuses on the ballistic missile threat but the summary points out and reiterates at several places that terrorist delivery of WMD directly against the United States is most likely to use delivery systems other than ballistic missiles. The 9/11 attacks did not employ WMD as such but used the unconventional delivery means of fully fueled civilian air liners diving into buildings as manned cruise missiles.

Global Threats and Challenges Through 2015

Thomas R. Wilson, edited by Defense Intelligence Agency, Washington, D.C.
Senate Armed Services Committee, 2001

Commissioned By
Statement for the Record to the Senate Armed Services Committee.

Purpose and Objectives
As the title "Global Threats and Challenges Through 2015" suggests, the unclassified statement is a broad and wide-ranging assessment of near term and long term threats to U.S. security and America's position in the world, covering globalization trends, proliferation, terrorism, and security problems with Russia, China, the Middle East, Korean peninsula, India-Pakistan, the Balkans, and Latin America.

Timeframe Examined
Near term, 12-24 months (through March 2003), and longer term, 10 to 15 years, or through 2015.

Prevailing Context
A time of "transition and turmoil" in the 1990s, from the Cold War issues to new security paradigms and problems. This assessment came 6 months before 9/11, early in the first George W. Bush administration, with rising concerns about terrorism as the most significant asymmetric threat to U.S. interests at home and abroad. India and Pakistan had gone nuclear in May 1998, and fought a brief, limited conventional conflict over Kashmir in the summer of 1999. UN sanctions on Iraq were under strain, and US/NATO engagements in the Balkans were a concern. About a year earlier, Russia announced changes in military doctrine indicating increased reliance on nuclear weapons to compensate for its diminished conventional military capabilities.

Methodology
This is a public DIA statement and based on DIA's style of estimative intelligence. No distinctive methodology is apparent. The statement is an assessment of trends and their impact on existing U.S. military and defense capabilities.

Report Format
The statement follows the outline below:
I. The Emerging Global Security Environment
- Globalization
- Global demographic trends
- Rapid technology development and proliferation

II. Key Near Term Concerns

- A major terrorist attack
- Worsening conditions in the Middle East
- Dramatic changes on the Korean peninsula
- An expanded India-Pakistan military conflict over Kashmir
- Intensifying disagreements with Russia
- Another outbreak of violence in the Balkans
- Increased anti-American violence and regional instability in Colombia, Latin America
- Conflict between China and Taiwan

III. Longer-Term Threats and Challenges
- Engagement challenges
- Asymmetric challenges
- Terrorism
- Information operations
- WMD and missile proliferation
- The foreign intelligence threat
- Cover, concealment, camouflage, denial and deception (C3D2)
- Counter-space capabilities
- Threats to critical infrastructure
- Criminal challenges
- Strategic challenges
- Regional military challenges
    - China
    - Russia
    - Iran
    - North Korea
- The bottom line

Key Projections/Forecasts

Motivations to acquire

To deter U.S. military pressure and divide the United States from its allies, and to be able to deny U.S. (allied) forces easy access to key theaters, ports, bases, facilities and air, land and sea approaches. Many potential adversaries believe they can preclude U.S. force options by developing WMD and missiles. Others are motivated more by regional threat perceptions. In either case, the pressure to acquire WMD and missiles is high.

Regions/countries of greatest concern

Russia, China, and North Korea remain the "WMD and missile" suppliers of primary concern. Russia has exported ballistic missile and nuclear technology to Iran, and China has provided missile and other assistance to Iran and Pakistan. North Korea remains a key source for ballistic missiles and related components and materials. Over time, as other nations (such as Iran) acquire more advanced [WMD and missile] capabilities, they too are

likely to become important proliferators. Iran and Iraq could acquire nuclear weapons during the next decade or so, and India and Pakistan as existing nuclear states will undoubtedly increase their inventories. Some 25 countries now possess – or are in the process of acquiring and developing – WMD or missiles. Meanwhile a variety of non-state actors are showing increasing interests.

Specific weapon types (N, B, C, R, Delivery Means), to include new or non-traditional weapons/effects/production techniques/delivery means

CW and BW are easier to develop, hide, and deploy than nuclear weapons and will be readily available to those with the will and resources to obtain them. More than two dozen states or non-state groups either have, or have an interest in acquiring, chemical weapons, and there are a dozen countries believed to have biological warfare programs. CW and BW will be widely proliferated, and over the next 15 years, they could well be used in a regional conflict or terrorist attack. The potential development/acquisition of ICBMs by North Korea, Iran, and Iraq could fundamentally alter the strategic threat. The numbers of longer-range theater (up to 3,000 km range) ballistic and cruise missile systems will increase significantly over the next 15 years, as will their accuracy and destructive impact.

For at least the next decade or so, Russia will rely increasingly on nuclear weapons to compensate for its diminished conventional capability. Russia will seek to modernize its strategic forces albeit at lower levels, deploying the SS-27 ICBM and continuing development of several other systems. China will seek to strengthen and modernize its small strategic nuclear deterrent. The number, reliability, survivability, and accuracy of Chinese strategic missiles capable of striking the United States will increase during the next 20 years.

Acquisition patterns/trends

New alliances have formed, providing pooled resources for developing WMD and missile capabilities. Globalizing conditions have made it easier to transfer material and expertise. A concern due to Russia's turmoil is the potential for a nuclear weapon or, more likely, nuclear material to be stolen or diverted to a state of concern, a terrorist group, or other criminal organization.

Deterrence and employment concepts

Adversaries understand U.S. civilian and military reliance on advanced information technologies and systems, and public opinion, and numerous potential foes are pursuing means to undermine support for U.S. actions, to attack key parts of the U.S. national infrastructure, or to impede our attainment of information superiority.

Areas for potential surprise

Middle East terrorist groups will remain the most important [terrorist] threat but our interests will be targeted worldwide. State sponsors (primarily Iran) and individuals with financial means (such as Osama bin Laden) will continue to provide economic and technological support to terrorists. A move toward "higher-casualty attacks" is predictable as

globalization provides terrorists access to more destructive conventional weapons technologies and WMD.

Specific forecasts

- Over time, as other nations (such as Iran) acquire more advanced [WMD and missile] capabilities, they too are likely to become important proliferators.
- Iran and Iraq could acquire nuclear weapons during the next decade or so.
- India and Pakistan as existing nuclear states will undoubtedly increase their [nuclear and missile] inventories.
- CW and BW are easier to develop, hide, and deploy than nuclear weapons and will be readily available to those with the will and resources to obtain them. One can expect CW and BW to be widely proliferated, and they could well be used in a regional conflict or terrorist attack over the next 15 years.
- The numbers of longer-range theater (up to 3,000 km range) ballistic and cruise missile systems will increase significantly over the next 15 years, as will their accuracy and destructive impact.
- The potential [and expected] development/acquisition of ICBMs by North Korea, Iran, and Iraq could fundamentally alter the strategic threat. North Korea's Taepo Dong II now under development could, if equipped with three stages, deliver a several-hundred kg payload anywhere in the United States. North Korea has the potential to field an ICBM sometime within the next several years. Under certain conditions, Iran and Iraq each could develop an ICBM capable of reaching the United States by 2015. If Iran purchased the TD II system from North Korea, it could attain ICBM capability earlier.
- For at least the next decade or so, Russia will rely increasingly on nuclear weapons to compensate for its diminished conventional capability.
- China will seek to strengthen and modernize its small strategic nuclear deterrent. The number, reliability, survivability, and accuracy of Chinese strategic missiles capable of striking the United States [about 20, in the current assessment] will increase during the next 20 years.
- A move toward "higher-casualty attacks" is predictable as globalization provides terrorists access to more destructive conventional weapons technologies and WMD.
- Although Iran's force modernization will proceed gradually, during the next 15 years it will likely acquire a full range of WMD capabilities, field substantial numbers of ballistic and cruise missiles – including, perhaps, an ICBM – increase its inventory of modern aircraft, expand its armored forces, and continue to improve its anti-surface ship capability. Iran probably will face obstacles to generating and employing this increase military potential against an advanced adversary.
- Should sanctions be removed or become ineffective, Iraq under Saddam Hussain will move quickly to expand its WMD and missile capabilities

Significant Points

Despite its breadth and unclassified status, this DIA statement is quite specific regarding WMD activities in particular countries of concern and also about these countries' relationships with Russia, China, and North Korea as missile and WMD technology suppliers (see previous two sections). The statement is also fairly accurate in its WMD and missile development projections and, read carefully, does not greatly overstate the WMD status of Iraqi programs under UN sanctions. Written before 9/11, Operation Enduring Freedom (OEF) in Afghanistan, and the March 2003 inception of the Iraq War, it could not reasonably forecast WMD-related consequences of those events. Subsequent developments suggest the forecast of North Korea fielding an authentic ICBM within the next few years has not held, but the characterization of the North Korean effort is correct on its direction. The statement flags the existence of evidence of terrorist group (particularly al-Qaeda) interest in WMD, later verified by discoveries on the ground in Afghanistan.

Other Major Conclusions and Unique Dimensions

No unique dimension of underlying defense intelligence studies stands out in this statement, but it is forward looking in warning of the broadened scope and complexity of U.S. military requirements related to asymmetric threats, particularly missiles and WMD, and how stretched U.S. forces may become in dealing with these challenges. The statement virtually omits any assessment, however, of defense threat-reduction programs in the Former Soviet Union.

Conclusions

Missile and WMD proliferation is expanding rapidly in a well known list of countries of concern, is heightening the risks of nuclear conflict between India and Pakistan, and will pose increasing challenges of asymmetric threat to U.S. interests, U.S. and allied forward military operations, and even to the U.S. homeland over the next 15 to 20 years. The Middle East, South Asia, and East Asia are the regions of greatest concern. Traditional strategic WMD threats (Russia and China) have either diminished (Russia) or are on a slow track (China), but are still growing. Emerging power WMD and missile threats are coming to the forefront as the new strategic problem. Middle East terrorism is the biggest immediate threat and sponsoring states and expressed terrorist interest in WMD gives this threat strategic importance.

Emerging Weapons of Mass Destruction Technologies: Impact on the Air Force

Jackie Geissinger, Michael George, Tim Miller, and Forest Waller
In AF Futures Project, U.S. Air Force, 2003

Note
Some of the assessed written work (e.g., a PowerPoint document), however, appears to be of 2006 or 2007 vintage.

Commissioned By
U.S. Air Force, AF/XO.

Purpose and Objectives
The focus of this study is to analyze those advancements in technology that could potentially become new types of WMD. Information technology affects virtually all elements of human activity and advancements in materials engineering, biological science and energy research are making a significant impact on both the civilian and military realms. The goal of this study is to understand what technologies may have such WMD potential and what their implications are for conflict in the future, U.S. national security policy, and the plans and policies of the U.S. Air Force.

Timeframe Examined
The timeframe examined is not explicit, but as a composite appears to be fifteen to twenty-five years.

Prevailing Context
The inspiration for the study was geared less to national/international events or politics than to an understanding of critical changes in key areas of technology.

Methodology
The study was conducted by first researching relevant documents on which technologies are emerging. This included testimony from intelligence officials, reports by think tanks, academic institutions, and various governmental research institutions. From the research emerged a guide to what technologies to further research and to ask two dozen technology and policy experts about during the interview phase. The research and interviews were synthesized and assessments, conclusions and recommendations were made.

Four of the most relevant documents in the literature review for this study were forecasts that looked at a range of futures. The four shared a common theme for the technologies that would be the most influential in the future:

- *Global Trends 2015: A Dialogue About the Future with Nongovernment Experts (2000)* which examined trends that will affect the world, including the advancement of science and technology, and more specifically, the fields of information technology, biotechnology, nanotechnology, and materials science.

- The Hart-Rudman Commission's report, *New World Coming: American Security in the 21st Century (1999)*, which looked out to 2025 and highlighted the impact of information technology, biotechnology, micro-electro-mechanical systems (MEMS), and advanced energy research as key future technologies.

- George Washington University's "GW Forecast" based on bringing experts together to forecast future technologies and trends within them, and concerned with how information technology, advances in medicine, micro-electro-mechanical systems (MEMS), and new energy technologies are accepted by the public.

- The Army Training and Doctrine Command conducts an exercise examining technology from the "Red Team" perspective. Dr. Dennis Bushnell, a NASA scientist, has taken the lead on this project. After reviewing the game over several years, Dr. Bushnell produced a 2001 briefing, *Future Strategic Issues/Future Warfare, Circa 2025*, in which he identified several technologies that could lead to new WMD. He examined information technology, biotechnology, advanced energy sources, and nanotechnology.

Report Format

I. Four technology revolutions

Based on the literature review and interviews with experts, four technology revolutions appeared to hold the most potential to produce technological advancements that could have massively destructive effects: information technology, biological science, nanotechnology, and advanced energy sources.

- **Information Technology:** Some experts believed cyberattack and IT operations could be used as a weapon of mass disruption but not as a weapon of mass destruction (WMD) that could itself cause casualties or damage property in a major way. All regarded IT as a key enabler in the advancement of other technologies and systems that will have the potential for massively destructive effects.
- **Biological Science:** A second area that will impact current and future WMD is biological sciences and advancements in bio-engineering. These developments offer many constructive possibilities for societies, but also can increase the potential dangers from pathogens like anthrax and smallpox and open the way to more virulent strains of these pathogens with new characteristics including survivability against vaccines and countermeasures and ability to evade detection.
- **Nanotechnology:** Although it is a relatively new field, nanotechnology and micro-scale electronic machines hold enormous potential for revolutionary changes in how humans live. This field holds the potential to create materials and electromechanical

devices that are stronger, smaller, lighter, and have a range of other key properties. Nanotechnology holds potential both as an enabler of other forms of WMD and as a weapon itself.

- **Advanced Energy Sources:** The benefits of such new sources of energy could be reduced pollution, more concentrated forms of energy, and more renewable sources. A myriad of energies are being investigated from solar power and biomass to new ways to release energy from chemical bonds and harnessing nuclear energies like pure fusion and nuclear isomers. While new energy sources have potential for benefits in energy efficiency and reduction in pollution, they can also be harnessed for WMD purposes.

II. Impact of the Technology Revolutions on Threat and Weapons Development

- **New Biological Weapons:** A key concern is over new pathogens derived from genetic engineering, but also in combination with nanotechnology processes. This could lead to pathogens that are more virulent, more resistant to vaccines or treatment, easier to deliver, and more persistent once delivered. A new generation of biological weapons could target specific groups, whether of a certain age, national background, or other characteristic. Strains of DNA, called aptamers, could be developed which could cause a particular disease but without the disease organism. Nano-particles capable of working at the subcellular level could be designed as molecular poisons evading normal cellular and physiological defense mechanisms. Another concept is binary BW, which would work by introducing a latent pathogen into a body that would later be activated by some environmental factor or exposure to a trigger.
- **Nanoscale Weapons**: The "new kinds" of WMD concern about nanotechnology is its potential both as an enabler of other forms of WMD and as a weapon itself.
  - ***As an enabler***, nanotechnology can be used to "improve" chemical, biological, and nuclear weapons. Leveraging the manufacturing techniques on a small scale could produce chemical weapons that are more lethal and hard to defend against or detect, or improve the ability to develop modified and more lethal biological pathogens. In the nuclear realm, nanotechnology would be a key to producing a new generation of nuclear weapons that are lower yield and cleaner.
  - ***As its own form of WMD***, nanotechnology could take several forms. Devices could have characteristics that make them undetectable or very difficult to detect due to their size, or be designed to act to avoid detection. Examples of possible nanotechnology weapons include: (a) explosive microdust – a cloud of nanoexplosives to fill in a large area or infiltrate spaces otherwise hard to reach; (b) "nanobots" – small destructive microelectronic machines that could be either directed or autonomous, able to attack individuals as a type of man-made BW but much harder to detect or defend against, or serviceable as delivery vehicles for biological pathogens); and (c) the use of nanoparticles, such as carbon fibers or nanotubes, to cripple personnel through inhalation.

- **Advanced Energy Weapons:** New energy sources can also be harnessed for WMD purposes.
  - In the nuclear weapons area, pure fusion, while potentially a significant source of energy, also makes development of nuclear weapons more difficult to detect and reduces the technical roadblocks to their acquisition, including "fourth" generation nuclear weapons with much smaller yield.
  - New advances in releasing energy from chemical bonds or by working at the atomic level, such as certain energy states of the element hafnium, could provide increased destructive potential from new forms of chemical explosives. Other ways to increase non-nuclear explosives are under research and conceivable in the field of "novel energetics", through strained-bond energy release, nuclear isomers, and the potential for antimatter. These technologies are in various stages of examination and theoretical work. However, they do have the potential for significant energy releases relative to TNT.
  - Microwave weapons are currently designed to affect electronic equipment, but can be configured to affect personnel, e.g., in crowd control situations. Microwaves can have anti-personnel effects through loss of control of the body, disorientation in the brain, and heating of the skin. Achieving mass effects from microwave weapons is a challenge due to the large input of energy required but in combination with other technological developments may be feasible.
  - Beside their potential as new forms of WMD, the new energy sources may aid in other forms of WMD, such as providing power to delivery vehicles. If more energy can be extracted from a smaller amount of matter, power sources for weapons can last longer or the weapons themselves could be made smaller.
- **New Delivery Systems:** The technological advances discussed above could generate new weapon delivery systems. These could take on various forms, but a common characteristic is that distance will be less of a concern, with the potential for intercontinental systems becoming more easily available:
  - Long-distance, ultra-light unmanned aerial and space vehicles based on nanotechnology, new materials, and more efficient energy sources.
  - Propulsion systems based upon novel methods, such as blast wave propulsion (BWP) systems and the slingatron concept. (a) BWP involves sequential detonation of charges behind a projectile (without a barrel) yielding ICBM or IRBM speeds after only 100 to 200 feet of acceleration. Essentially this is a 'rocket' in which the external structure and propellant never leave the launcher - only the warhead. A BWP would offer not only stealthy launch - no plume - but also exceptional flexibility, affordability, and survivability, while retaining the ability to be recalled. (b) The Slingatron would use an oscillating horizontal tube - much like a 'hula-hoop' - to accelerate projectiles in a spiral path until launch velocity is reached. Such an arrangement appears capable of lofting hundreds to thousands per minute of ten-kilogram projectiles over even intercontinental ranges. (c) These new forms of delivery can be paired with new guidance systems,

whether the current GPS, networked nanosensors, or other future systems for precise delivery of payloads.

- **Technology Synergy:** A key factor for future WMD is the prospective combination of advances from several of the technology revolutions. For example, new ultra-high explosives individually may not approach the power of a nuclear weapon, but if combined with new delivery systems that can mass attacks into a particular geographic area with precision, they would have massively destructive effects. In the case of microwave weapons, while some experts doubt their ability to be used in a massively destructive manner, advances in energy sources and materials could allow the energy needs of microwave weapons to be met to allow for WMD-like effects.
- **Technological Possibilities:** Like all predictions, examining the potential for technology is an uncertain endeavor. Some technologies of concern may not receive the funding to further develop technologies or there may be fundamental limitations in physics that prohibit the development of these technologies in the ways discussed. The technology experts interviewed had differing views on these new technologies and their potential. However, it appears likely that some technologies that emerge from the technological revolutions will result in effective and affordable weapons.

III. Interview Results

Interviews were conducted with individuals possessing a range of experience, including the Defense Science Board, the Air Force Research Lab, the Department of Energy nuclear programs, and DoD's Defense Research and Engineering Office. In all, over two dozen interviews were conducted. In the course of the interviews a series of themes emerged – with implicit forecasts – on the future of new weapons of mass destruction technology:

- **Technology Potential:** Some of the interviewed experts were skeptical that some of the prospective technologies could become militarily effective, controllable, or affordable, or that there would be an incentive to develop them for WMD capability and effects. They doubted that three of the technologies investigated would actually be developed as WMD: lasers and directed energy weapons, enhancements to conventional explosives, and information technology. Of the technologies that do have WMD potential, nanotechnology, advanced energy sources, biotechnology and robotics were mentioned.
- **U.S. Technology Leadership:** Respondents noted that while the U.S. generally is a leader in the technology areas of interest, it does face competition from European and Asian countries. However, it faces little competition from nations outside of the G-8 and China. In certain niche technologies the U.S. does not have the lead, e.g., in wireless communications or in high quality, high technology manufacturing. This diversity in global technology R&D means that the U.S. may not be the source of technology breakthroughs and how they are used and disseminated.
- **Controlling New Technologies:** Experts commented on the feasibility and desirability of controlling these technologies and their developments. A general

theme emerged that these technologies are too immature and their potential for benefit or harm is still unknown and it would not make sense to place political controls on them this early in their development. In addition, it was felt that such controls would not likely be accepted by other nations, both because of the technologies' unknown potential and the high likelihood that new technologies would have significant commercial uses beyond the military ones that might be envisioned.

- **Definition of WMD:** One theme that emerged from the interviews is that the definition for WMD, as currently formulated, is inadequate. Some felt that only nuclear weapons belong in that category because of their massive destructive power, and not BW, CW, or radiological. Others pointed out the weapons that could be derived from the new technologies being developed, or that attacks based on a system of system approach using current and future technology, could be added to the definition. Some noted that IT technologies, e.g., used for cyberattack, might not be massively destructive but could be massively disruptive and classed as "weapons of mass disruption."
- **Rationale for New WMD:** Some interviewees were skeptical adversaries would seek new kinds of WMD, because the current versions, particularly nuclear, could not be topped. Some felt that the developed nations would have no need to develop new WMD because of the general trend toward warfare based on precision, not on mass destruction. Respondents also stated that less developed states and non-state actors would likely focus on current WMD like BW or nuclear weapons, and would leverage any advancements in technology from the developed states.

IV. What implications do such developments have for warfare, U.S. security policy, and Air Force Plans & Policy?

- **New WMD are likely to appear:** As technology evolves in IT, nanotechnology, new energy systems, and biotechnology, the "traditional" WMD will become more dangerous.
  - The increased threat will come from making nuclear weapons programs harder to detect, more powerful but with smaller payloads, and advances in biological weapons in terms of their: ability to infect, virulence, persistence, and resistance. The ability of state and non-state actors to develop and possess these weapons will improve.
  - With the technology revolutions, not only will "improvements" occur with current WMD but new technologies will likely allow the development of new weapons that will have massively destructive effects. These new systems could come in different forms, whether new high explosives that when combined with affordable, long-distance UAVs can deliver a swarming effect and cause massive destruction or new non-biological pathogen-like effects from nanites.
  - Not all of these technologies will make this transition if they are feasible, but some will.

  - These developments are not likely to happen soon, providing the luxury of time to monitor developments and create a response.
- **New technologies may be disruptive:** Several technologies envisioned by the study may be disruptive in the sense that developed countries may not view them as effective or as good as the technology in their inventory. However, these technologies might provide a niche capability to an adversary to overcome an aspect of U.S. strength. For example, small light weight, long-distance UAVs may not be pursued by the U.S., but may fill a role for an adversary, perhaps because they are cheaper and provide enough capability, whereas the U.S. may not see such systems fitting in its inventory.
- **Political Controls:** Although some experts believe political controls may not work, may not be necessary, or may be premature, they may nonetheless serve a useful role. Political controls can be used to limit or stop new technologies from getting in the hands of rogue states or non-state actors. They can help establish "rules of the road" for new technologies, laying out what is and is not acceptable. Given such rules, political controls would allow national and international responses to those who violate the rules.
- **WMD definition:** The current NBC (or CBRNE) definition of WMD tilts towards a political selection of targets and swift interactions between weapon and target. The definition creates blinders because it does not address other technologies that potentially could produce massive destructive effects. If such threats are overlooked, strategic surprise is a possibility. This could lead to a loss of public confidence in the government's ability to protect the country.
  - A new definition of WMD might take into account that there are several sources of massively destructive effects beyond those associated with NBC technologies. These would include new technologies and a broader range of the types of events that are massively destructive.
  - One way to view these events is to quantify the total destruction in a given physical or geographic space and add together the effects over time, rather than merely counting the immediate number of casualties of a sudden discrete attack. A formula to quantify massively destructive acts could standardize them on an 'effects-based' Mass Destruction Index (MDI), which takes the form: (C/T) x K, where C = Casualties, T = Target Area, and K = Scaling Constant. So quantified, two attacks that did not use WMD as currently defined – the Tokyo fire-bombing of 9-10 March 1945 (MDI = 63) and the Twin Towers attack of 11 September 2001 (MDI=113) – come out higher on the MDI than the atomic bomb attacks on Hiroshima (MDI=34) and Nagasaki (MDI=44) in August 1945. This effects-based comparison gives more attention to 'effect on target' than characteristics of the weapon, is flexible on the time period for weapon-target interaction, and an expanded list of massively destructive events – and thus longer list of WMD.
  - A case can also be made for leaving the definition as is because the technologies discussed here are in the future and it is unclear which of them will develop.

Because of this time lag in development, the U.S. has the luxury of time to analyze and reflect upon the most appropriates responses.

- **Aid to the Air Force:** While challenging Air Force operations and missions, the technology revolutions will also provide the Air Force with access to technologies that will enhance its capabilities. Improvements could come in precision strike, the payloads available to the service, as well as new modes of propulsion and enhanced C4ISR. New capabilities will also provide the Air Force new capabilities to combat the threat from any new WMD. For example, nanotechnology may provide the ability to improve sensors against traditional and new biological weapons, mitigating the current detection problem.
- **Challenges to the Air Force:** The new kinds of WMD would pose several challenges to the Air Force.
  - New kinds of WMD could complicate the Air Force role of providing air defense of the U.S. if new technologies allow rapid, intercontinental delivery of payloads or difficult to defend against swarms of small UAVs. New WMD may also call into question the Air Force's ability to maintain air superiority and continental United States (CONUS) and forward bases for power projection.
  - Attack detection and assessment will be more complex. If new forms of BW are developed or non-organic forms of BW-like attacks are developed with nanotechnology, then detecting and assessing an attack will be that much harder.
  - Higher potential destruction from new kinds of non-nuclear explosives: If the technology develops to increase the explosive yield of non-nuclear weapons, whether by improving the energy release from conventional explosives or using techniques like nuclear isomers, then adversaries can cause more damage with smaller attacks or smaller payloads. This exposes the Air Force to the potential for more destructive payloads.
  - The sum of much of this will be that an adversary will have an increased ability to strike Air Force bases, from longer distances away, with more precision, with more firepower, and in some cases, without detection.
- **National security impact:** The new kinds of WMD are not a problem solely for the Air Force; they will challenge all elements of U.S. national security and homeland security. The characteristics for some of these weapons pose unique challenges or duplicate challenges posed by the current generation of WMD.
  - Detection of these new methods will be difficult. Nanotechnology, biotechnology, and new energy sources all can have dual-uses.
  - Determining which programs by other nations are for military purposes and which are for civilian purposes will be a significant challenge.
  - Detection of an actual attack will also be difficult in some cases. Like the current concerns over detecting a biological attack, detecting an attack of non-organic, "invisible" nanites, from anti-respiratory nanotubes or other hard to detect materials, will pose a serious problem and require new forms of detection. Similarly attacks carried out using swarms of small, long-range UAVs may be difficult to detect because UAVs fly below radar.

- Defending against new types of WMD will also be a problem. Whether the attacks are by small nanomaterials, new delivery systems that can deliver projectiles rapidly, or swarms of precisely guided UAVs, current U.S. technology will have a difficult time providing a defense.
- The new WMD could challenge some key elements of the approach the U.S. takes to warfighting. For example, air dominance may be called into question or made irrelevant by some of the new delivery systems. This might entail small, long-distance UAVs that swarm an area with ultra high-explosives. Air Force air defense techniques would be hard-pressed to stop such an attack if hundreds or thousands of such UAVs were involved. These could overwhelm the advantage the U.S. has in aircraft technology. They also call into question the ability of the U.S. to protect U.S. and overseas bases as staging areas for operations.

Key Projections/Forecasts

Motivations to acquire

This study did not deal concretely or specifically with the motivations of particular actors and adversaries around the world to acquire WMD but generally assumed that the expansion of technological opportunities would lead some adversaries to adopt some of the options.

Regions/countries of greatest concern

This study was focused on technological change in generic terms and not on specific adversaries. It contains no forecast content on specific countries or regions, other than on where technology R&D is advanced and may pose competitive conditions for the United States.

Specific weapon types (N, B, C, R, Delivery Means), to include new or non-traditional weapons/effects/production techniques/delivery means

This study does address the "possibilities" of new types and new kinds of weapons, including new delivery system concepts, that could challenge U.S. national security and could pose threats that the U.S. Air Force would need to be able to counter – but in generic rather than regional or country-specific terms. The study projects such possibilities in terms of judgments about their "limited potential" or "high potential" but does not forecast timelines for these technologies to materialize.

- Limited Potential (for WMD):
  - *High-energy lasers* and *directed energy weapons* (DEW) (noting however that Physics does not support DEW as WMD);
  - *New chemical high explosives* (noting that there are limits to high explosive energy release and "consecutive miracles" would be required to develop materials and mechanisms that could achieve destructive results similar to nuclear explosives);

- *Information technology* and *information operations* (IO) could, at present, achieve "disruptive" effects but not mass destruction effects (i.e., not mass casualties).

- High Potential (for WMD):
  - *Nanotechnology* and *Micro-Electro-Mechanical Systems*;
  - *Advanced energy sources and devices* (e.g., for new long-range delivery systems of kinetic or high explosive weapons);
  - *Biotechnology* and *genomically engineered weapons*; and
  - *Artificial Intelligence* (AI) and *Robotics* (e.g., 'Swarms' of smart, small, unmanned weapons focused on key centers of gravity or creating massively destructive effects).

Acquisition patterns/trends

This study did not address or forecast acquisition patterns/trends of WMD proliferating states or entities, other than to note that certain other countries/regions of the world may be ahead of the United States in certain niche technologies.

Deterrence and employment concepts

This study deals more with U.S. opportunities to adapt deterrence and employment concepts to changes in weapons technology for U.S. defense operations and does not forecast or speculate on the deterrence or employment concepts of potential adversaries that may engage in WMD proliferation. The U.S. opportunities are covered in other sections, above.

Areas for potential surprise

The current NBC (or CBRNE) definition of WMD tilts towards a political selection of targets and swift interactions between weapon and target, but its narrow perspective on a handful of technologies creates blinders since it overlooks other technologies that potentially could produce massive destructive effects. If such threats are overlooked, as with a system of systems approach in the case of the attacks of September 11, 2001, then strategic surprise is a possibility. This could lead to a loss of public confidence in the government's ability to protect the country.

Specific forecasts

- **New WMD are likely to appear:** As technology evolves in IT, nanotechnology, new energy systems, and biotechnology, the "traditional" WMD will become more dangerous.
  - The increased threat will come from: making nuclear weapons programs harder to detect, more powerful but with smaller payloads, and advances in biological weapons in terms of their ability to infect, virulence, persistence, and resistance. The ability of state and non-state actors to develop and possess these weapons will improve.

- With the technology revolutions, not only will "improvements" occur with current WMD but new technologies will likely allow the development of new weapons that will have massively destructive effects. These new systems could come in different forms, whether new high explosives that when combined with affordable, long-distance UAVs can deliver a swarming effect and cause massive destruction or new non-biological pathogen-like effects from nanites.
- Not all of these technologies will make this transition if they are feasible, but some will.
- These developments are not likely to happen soon, providing the luxury of time to monitor developments and create a response.

- **Aid to the Air Force:** While challenging Air Force operations and missions, the technology revolutions will also provide the Air Force with access to technologies that will enhance its capabilities. Improvements could come in precision strike, the payloads available to the service, as well as new modes of propulsion and enhanced C4ISR. New capabilities will also provide the Air Force new capabilities to combat the threat from any new WMD.

Significant Points

- The current definition of WMD is problematic, but broadening the definition of WMD to encompass certain new technologies could also inhibit needed U.S. R&D and defense programs by creating controversy over the production and use of WMD.
- Although powerful "new kinds" will eventually emerge, nuclear will remain the gold standard for many years.
- Future changes of technology will pose challenges and threats but also add to the capabilities and means of the U.S. Air Force in combating new threats.

Other Major Conclusions and Unique Dimensions

The unique dimensions of the study are of several kinds: (1) reviewing and assimilating the findings from a series of long-range studies by other entities on the characteristics and implications of future technological change; (2) interviews of well-informed policy and technical experts on a series of dimensions extracted on forecasts of technological change and threats to U.S. national security; (3) an operational focus on the implications of the findings for the long term requirements of the U.S. Air Force; and (4) a conceptual and policy-relevant critique of the definitions and terminology related to "weapons of mass destruction".

Conclusions

- Powerful "new kinds" & disruptive military systems are likely to appear as technology revolutions mature/merge.
  - Some early products are ready for prototyping; nuclear will remain the "gold standard" for many years.
- Many "new kinds" approaches escape existing proliferation constraints.
- Few in policy positions recognize "new kinds" as a problem.
- Greater awareness of disruptive technologies challenge.
- U.S. leadership in "new kinds" or disruptive military technology is uncertain; competition is intense.
  - "New kinds" technologies may appear first among U.S. adversaries.
- Good reasons exist for changing U.S. definition of WM: WMD definition is incomplete now; obsolete as technology progresses.
- Strong reasons also exist, however, for leaving the definition alone; policy, programmatic, and operational impacts must be weighed (expansive definition could make new U.S. weapons choices 'become' WMD by definition).
- "New kinds" & disruptive technologies could challenge important DOD operational expectations.
- "New kinds" & disruptive technologies are not uniquely an Air Force problem– they are a national problem.
- Four technology revolutions will dramatically improve Air Force capabilities in key mission areas.
- Air Force should be concerned about new kinds technologies or disruptive systems in adversary hands:
  - Genomic biological weapons;
  - Destructive MEMS/nanites;
  - Ultra-high explosives & ultra-incendiary devices;
  - Electromagnetic weapons; and
  - Small, smart, swarming, mass-effects systems.
- Challenges to Air Force include:
  - "New kinds" could complicate key USAF missions (e.g., Homeland defense, power projection, precision attack, space control, air superiority);
  - Early detection/attack assessment likely to be more complex;
  - Higher energies for non-nuclear weapons means more destruction; and
  - A much larger OPSEC problem.

Biotechnology: Impact on Biological Warfare and Biodefense

Mary Ann Liebert and James B. Petro
Biosecurity & Bioterrorism 1, no. 3 (2003): 161-68

Purpose and Objectives
The stated purpose is "to highlight the impending potential for biotechnology to revolutionize concepts underlying development, weaponization, and limitations of biological agents for" biological warfare.

Timeframe Examined
Timeframe is not explicit, but implicitly looking out ten years and beyond (2013-2020); the thesis is that "advanced biological warfare" (ABW) agents could materialize about ten years out.

Prevailing Context
No specific events indicated, but, based on date of publication about a year after 9/11, one would surmise that the shock of 9/11 itself and subsequent discovery in Afghanistan of evidence of al-Qaeda's experimentation with chemical and biological weapons (CW/BW), and perhaps other developments in the international terrorist threat were significant in the context of this article.

Methodology
This article is not a study as such but rather a think piece that synthesizes judgments about future threats based on the several authors' special knowledge of Biotechnology and Biosecurity issues.

Report Format
The article is outlined as follows:

- Introduction
- Traditional and Genetically Modified BW Agents
- Advanced Biological Warfare (ABW) Agents
- Implications for Downstream BW Processes
- Production
- Weaponization
- Delivery
- New BW Use Options
- Challenges for Biodefense
- Counterproliferation
- Attribution
- Need for "Next-Generation" Approaches to Biodefense

Key Projections/Forecasts

Motivations to acquire

The article is focused on biological agents and not on specific foreign users. Hence, there is no specific content on motivations, other than the potential appeal to hostile states or entities of biotechnology and BW options as asymmetric weapons that have low cost-to-effect ratios, few technical barriers, and force multiplier potentials.

Regions/countries of greatest concern

The article is theoretical and does not delve into regions or countries of greatest concern, other than to suggest generically that traditional as well as some of the novel techniques and BW uses could appeal to technologically proficient rogue nations and possibly sophisticated terrorist organizations (given asymmetric weapon characteristics above).

Specific weapon types (N, B, C, R, Delivery Means), to include new or non-traditional weapons/effects/production techniques/delivery means

- The assessment deals with three categories of biological warfare agents: (1) Traditional Agents (e.g., naturally occurring pathogens like anthrax and smallpox, and toxins; (2) genetically-modified Traditional Agents (e.g., antibiotic-resistant bacteria); and (3) Advanced Biological Agents (e.g., novel BW agents created using recombinant DNA or other biotechnological applications).
- The assessment surmised that traditional agents have been the dominant threat for about a century and probably will remain the dominant threat concern for about ten years, but anytime after that genetically-modified agents and advanced biological warfare (ABW) agents will be developed and become part of the threat spectrum. The genetically-modified threats have a finite potential and eventually would plateau out, but the capability-based ABW potentials are multiplicative and will continue to expand indefinitely in parallel with advances in biotechnology.
- The ability to introduce foreign genes into animal and plant DNA in a way that allows the organism to produce new proteins (transgenic systems) has benign and potentially malign options. Transgenic plants could produce bioregulatory or toxic proteins and be introduced with benign counterparts to cause injury. Transgenic insects could be developed to produce and deliver protein-based biological warfare agents, and be used offensively against targets in a foreign country.
- Nano-research in pharmaceuticals may employ micro-encapsulation technology to encapsulate biologically active organisms, proteins, and even DNA within a coating nanoparticle substance, with increased capacity for storage and survival, and increased ability of bioproducts to be disseminated as an aerosol.
- Research on genetic and molecular mechanisms that regulate biofilm formation in complex sugars may protect bacteria colonies not only from environmental hazards but allow them to avoid the host immune system. Discoveries in this field may be diverted to enhanced storage and delivery of bacterial warfare agents.
- A systems approach to the creation of novel BW agents will likely occur concurrently with development of more advanced methods for agent delivery.

Because ABW agents will be targeted against specific biochemical pathways, lethal dosage may be reduced, while "vectors" (organisms or mechanisms to transmit a biological compound) that formerly could not be used for biological warfare now would become potential delivery vehicles. Viral vectors developed to carry and express foreign genes could permit targeted delivery of nucleic acid-based BW agents. Engineered viral vectors could use alternative strategies for delivery, including lipid-based and other non-colloidal vectors. The ultimate expression of this technology would be development of a vector that encapsulates, protects, penetrates, and releases DNA-based BW agents into target cells but is not recognized by the immune system. Such a "stealth" agent would be a huge challenge to current medical countermeasure strategies.

Acquisition patterns/trends

Application of biotechnological advances which have revolutionized many processes associated with bacterial and viral production and purification of proteins, reduce the technical expertise needed to produce bio-agents in quantity and quality.

Deterrence and employment concepts

The wide range of effects that can be designed into ABW agents will expand employment options and ultimately may decrease the current threshold for use of biological warfare. Among the new use options would be the opportunity, for example, to covertly target a civilian population for strategic effect with minimal risk of attribution.

Other properties favoring development of ABW agents may include: (1) customizable features allowing predictable, desired results following agent release; (2) concealment of BW attack as a natural out-break; (3) novel BW agents that circumvent vaccines or treatments against traditional agents and that are commensurately difficult to diagnose and treat; (4) novel agents tailored to target a specific population based on genetic or cultural traits; (5) novel agents that have sterilizing, oncogenic (cancer-causing), or debilitating effects could be created to use as a strategic weapon against a target population for long-term effects.

Areas for potential surprise

The range of ABW products possible from biotechnological advances is replete with possibilities of surprise, although proactive research and enhanced detection methods may be able to limit the scope of surprises.

Specific forecasts

- Biotechnology will significantly affect the global proliferation of agents of concern in a manner that will be difficult to monitor or regulate. Genomes of many organisms have been determined and stored as digital data files that are commonly accessible in a non-attributable manner over the Internet. It is becoming possible to reconstruct viruses from digital genomic data files, a process recognizable as "digital proliferation." As the number of commercial DNA synthesis enterprises

increases, standard approaches to monitoring the spread and acquisition of organisms on the CDC select agent list will become less effective.
- The way in which ABW agents are engineered will automatically permit them to circumvent systems currently under development to permit detection of threats posed by traditional agents. New profiling systems are need to ensure detection of a wide range of pathogens, both traditional and ABW agents.
- ABW agents will pose the greatest challenge to development of appropriate medical countermeasures. Given that ABW can be engineered to circumvent standard medical countermeasures, there will be an increasing need for research into novel strategies for protecting military and civilian populations from agents of unknown properties and origin.

Significant Points

- Unfortunately, the potential threat presented by the proliferation of biotechnology information cannot be contained as easily as the threat presented by nuclear fission research. Unlike much of the fission research, which has few applications except to the development of nuclear weapons, all biotechnology research builds on previous findings across a variety of disciplines. Restricting the spread of discoveries in the biological sciences may well impede progress in development of new therapeutics and vaccines, including those that will be essential to biodefense.
- Intelligence and domestic security communities will need to engage the published literature head-on and develop systems to monitor access to questionable research findings via pattern recognition. The national security community will need to become more engaged in educating academic and industrial researchers regarding foreign exploitation efforts and in establishing approved mechanisms for communicating suspicious activity. Identifying potential malefactors based on their information requirements should be possible. Additional counterproliferation efforts could then be targeted against individuals of concern.
- The potential for attribution could be increased by incorporating software into DNA synthesizers that "tags" products with signature sequences.

Other Major Conclusions and Unique Dimensions

No discernible unique dimensions of this think piece. However, as a series of propositions about potential biological threats and steps needed to counter them, it is an illuminating and persuasive article.

Conclusions

A variety of steps should be taken to upgrade biodefense capabilities: (1) Resources should be allocated to permit evaluation of emerging biotechnologies that may foster ABW agent development and to prioritize possible threats among them; (2) A federally funded venue for experimentally validating biotechnology threat assessments needs to be established at a single federal facility, along with an independent panel of bioscience experts responsible for approving and reviewing research at the facility; and (3) Some federal funds should be

dedicated to promoting development of next-generation systems for environmental detection, medical diagnostics, prophylactics, and therapeutics.

Successful implementation of a national biosecurity strategy will require integration of a variety of independent efforts across the federal, bioscience research, and medical/public health communities, devoted to protecting populations against bioterror attacks employing the traditional BW agents that will remain the primary threat for the next few years. However, further effort must be devoted to the potential for biotechnology to have an impact on biological warfare in a manner that exponentially amplifies the threat both to civilian and military populations.

Mapping the Global Future

In NIC 2020 Project. Washington, D.C.
National Intelligence Council, 2004

Commissioned By
The National Intelligence Council.

Purpose and Objectives
The purposes are to "map" (decipher) how the world is changing, what determinants count most in shaping those changes, and what this implies for the promotion or protection of U.S. interests, position, and leadership in global affairs. The introduction to the study postulates a number of assumptions, that the traditional post-war fault lines of East-West conflict and the North-South divide have lost their former relevance while shifts in emerging power status (e.g., China and India as "rising powers") and the growing importance of religious identity politics across broad regions are reshaping global geopolitics. Thus, the study attempts to map the effects of globalization variables driving change within a perspective that assumes broad shifts in geopolitics. Among the inspirational concepts is the idea of mapping non-linear changes through scenarios with alternative futures.

Timeframe Examined
2004-2020 (fifteen years)

Prevailing Context
The immediate context in which the study was commissioned appears to be its place as third in the series of NIC-sponsored efforts, beginning in the 1990s, to anticipate the implications of globalization and various drivers of change in the post-Cold War environment and the transition to the new millennium for challenges to the United States in international affairs. The study is not focused narrowly on national security issues but rather broadly on geopolitics, including shifts in major power positions, interaction with global and regional communities, and the impact of political, economic, and technological changes. This 2004-2020 study began about two years after 9/11, but does not appear to be driven mainly by those terrorist events. The contents of this NIC study also reflect awareness of the first year or so of the U.S.-led coalition's occupation of Iraq.

Methodology
"Mapping the Global Future" built on "Global Trends 2015," a NIC-sponsored team project that identified seven key drivers of global change: demographics, natural resources and the environment, science and technology, the global economy and globalization, national and international governance, future conflict, and the role of the United States. "Global Trends 2015" was based upon discussions between the NIC and selected nongovernmental organizations and experts in the United States about the forces that will shape our world. "Mapping the Global Future" picks up where Global Trends 2015 left off

but differs from the earlier efforts in three principal respects: (1) Foreign experts were also engaged in a series of regional conferences to obtain an authentically global perspective;. (2) scenarios were used to envisage how key trends might play out, offering several plausible alternate futures; and (3) the project developed an interactive Web site to facilitate continuing dialogue.

The approach, combining NIC and nongovernmental expertise was unique in its scope and breadth of participation, as an effort to chart key areas of change and how they shape the future. After scenario concepts were explored, critiqued, and debated within a Scenario Steering Group set up by the NIC, and with other groups that the NIC engaged, eight global scenarios that held particular promise were developed. The NIC then held a wrap-up workshop with a broader group of experts to examine the eight scenarios, discuss the merits and weaknesses of each, and ultimately narrow the number of scenarios included in the final publication to four. The scenarios depicted in this publication were selected for their relevance to policymakers and because they tend to force experts to question key assumptions about the future–although the scenarios do not attempt to predict it.

WMD-related technologies and threats represent one theme, but only one, in this broad NIC-sponsored effort. This assessment focuses on its WMD content, particularly trends and forecasts of WMD, and the geopolitical or military context of that WMD content as it is treated by the report.

Report Format

The format, scope and organization of this report are indicated by the table of contents:

Executive Summary
Methodology
Introduction
I. The Contradictions of Globalization
– An Expanding and Integrating Global Economy
– The Technology Revolution
– Lingering Social Inequalities
– ***Fictional Scenario: Davos World***

II. Rising Powers: The Changing Geopolitical Landscape
– Rising Asia
– Other Rising States?
– The "Aging" Powers
– Growing Demands for Energy
– U.S. Unipolarity – How Long Can it Last?
– ***Fictional Scenario: Pax Americana***

III. New Challenges to Governance
– Halting Progress on Democratization

– Identity Politics
– ***Fictional Scenario: A New Caliphate***

IV. Pervasive Insecurity
– Transmuting International Terrorism
– Intensifying Internal Conflicts
– Rising Powers – Tinder for Conflict?
– The WMD Factor
– ***Fictional Scenario: Cycle of Fear***

Policy Implications

Key Projections/Forecasts

Motivations to acquire

Growing distrust of U.S. unipolarity (U.S. assertiveness as sole superpower) could prompt governments to take a more hostile approach, including resistance to support for U.S. interests in multinational forums and development of asymmetric military capabilities as a hedge against U.S. exercise of military force.

Given the goal of some terrorist groups to use weapons that can be employed surreptitiously and generate dramatic impact, the report's authors expect to see terrorist use of some readily available biological and chemical weapons.

Regions/countries of greatest concern

China

The country will continue to strengthen its military by developing and acquiring modern weapons, including advanced fighter aircraft, sophisticated submarines, and increasing numbers of ballistic missiles. China will overtake Russia and others as the second largest defense spender after the United States over the next two decades and will be, by any measure, a first-rate military power.

Middle East and Muslim World

Growing numbers of people around the world, especially in the Middle East and the broader Muslim world, believe the U.S. is bent on regional domination–or direct political and economic domination of other states and their resources and may seek asymmetric military capabilities as countermeasures.

Countries Susceptible to Internal Conflict

For the most part, those states most susceptible to violence are in a great arc of instability from Sub-Saharan Africa, through North Africa, into the Middle East, the Balkans, the Caucasus and South and Central Asia and through parts of Southeast Asia. Countries in these regions are generally those "behind" the globalization curve.

Specific weapon types (N, B, C, R, Delivery Means), to include new or non-traditional weapons/effects/production techniques/delivery means

- Most terrorist attacks will continue to employ primarily conventional weapons, incorporating new twists to keep counterterrorist planners off balance. Terrorists will probably be most original not in the technologies or weapons they employ but rather in their operational concepts – i.e., the scope, design, or support arrangements for attacks. One such concept that is likely to continue is a large number of simultaneous attacks, possibly in widely separated locations.
- While vehicle-borne improvised explosive devices will remain popular as asymmetric weapons, terrorists are likely to move up the technology ladder to employ advanced explosives and unmanned aerial vehicles.
- Terrorist use of biological agents is therefore likely, and the range of options will grow.
- Security will remain at risk from increasingly advanced and lethal ballistic and cruise missiles and unmanned aerial vehicles (UAVs). States almost certainly will continue to increase the range, reliability, and accuracy of the missile systems in their inventories.
- By 2020 several countries of concern probably will have acquired Land-Attack Cruise Missiles (LACMs) capable of threatening the U.S. Homeland if brought closer to U.S. shores. Both North Korea and Iran probably will have an ICBM capability well before 2020 and will be working on improvements to enhance such capabilities, although new regimes in either country could rethink these objectives.
- Several other countries are likely to develop space launch vehicles (SLVs) by 2020 to put domestic satellites in orbit and to enhance national prestige. An SLV is a key stepping-stone toward an ICBM: it could be used as a booster in an ICBM development.

Acquisition patterns/trends

- Even as the dispersion of biotechnology promises a means of improving the quality of life, it also poses a major security concern. As biotechnology information becomes more widely available, the number of people who can potentially misuse such information and wreak widespread loss of life will increase. An attacker would appear to have an easier job–because of the large array of offensive possibilities available–than the defender, who must prepare against them all.
- Countries will continue to integrate both chemical and biological weapon (CW/BW) production capabilities into apparently legitimate commercial infrastructures, further concealing them from scrutiny, and BW/CW programs will be less reliant on foreign suppliers.
- The most worrisome trend has been intensified attempts by some terrorist groups to obtain weapons of mass destruction. It is of the greatest concern that these groups might acquire biological agents or less likely, a nuclear device, either of which could cause mass casualties.

- The assistance of proliferators, including former private entrepreneurs such as the A.Q. Khan network, will reduce the time required for additional countries to develop nuclear weapons.

Deterrence and employment concepts

India and Pakistan appear to understand the prices to be paid by triggering a conflict could be very high, but because nationalistic feelings run high a conflict is possible. Under plausible scenarios Pakistan might use nuclear weapons to counter success by the larger Indian conventional forces, particularly given Pakistan's lack of strategic depth.

Areas for potential surprise

- With advances in the design of simplified nuclear weapons, terrorists will continue to seek to acquire fissile material in order to construct a nuclear weapon.
- Concurrently, they can be expected to continue attempting to purchase or steal a weapon, particularly in Russia or Pakistan. Given the possibility that terrorists could acquire nuclear weapons, the use of such weapons by extremists before 2020 cannot be ruled out.
- If governments in countries with WMD capabilities lose control of their inventories, the risk of organized crime trafficking in nuclear, biological, or chemical weapons will increase between now and 2020.

Specific forecasts

- As biotechnology advances become more ubiquitous over the next 10 to 20 years, stopping the progress of offensive BW programs will become increasingly difficult; there is a risk that advances in biotechnology will augment not only defensive measures but also offensive biological warfare (BW) agent development.
- Major advances in the biological sciences and information technology probably will accelerate the pace of BW agent development, increasing the potential for agents that are more difficult to detect or to defend against. Through 2020 some countries will continue to try to develop chemical agents designed to circumvent the Chemical Weapons Convention verification regime.
- With advances in the design of simplified nuclear weapons, terrorists will continue to seek to acquire fissile material in order to construct a nuclear weapon.
- Over the next 15 years, a number of countries will continue to pursue their nuclear, chemical, and biological weapons programs and in some cases will enhance their capabilities.
- Current nuclear weapons states will continue to improve the survivability of their deterrent forces and almost certainly will improve the reliability, accuracy, and lethality of their delivery systems as well as develop capabilities to penetrate missile defenses.
- The open demonstration of nuclear capabilities by any state would further discredit the current nonproliferation regime, cause a possible shift in the balance of power, and increase the risk of conflicts escalating into nuclear ones.

- Countries without nuclear weapons, especially in the Middle East and Northeast Asia, may decide to seek them as it becomes clear that their neighbors and regional rivals already are doing so.
- Given the goal of some terrorist groups to use weapons that can be employed surreptitiously and generate dramatic impact, the report's authors expect to see terrorist use of some readily available biological and chemical weapons.

Significant Points

- Asia is the likely locus of major future conflicts, e.g., with China over Taiwan, with North Korea over the Korean peninsula, or between India and Pakistan as nuclear powers, but the likelihood of large conflicts (resembling the previous world wars or former Cold War potential for an East-West nuclear exchange) is low. Limited local and internal conflicts are likely to be commonplace, however, in the Middle East, Africa, and even in parts of Latin America.
- Biotechnology research and innovations derived from continued U.S. investments in Homeland Security–such as new therapies that might block a pathogen's ability to enter the body–may eventually have revolutionary healthcare applications that extend beyond protecting the U.S. from a terrorist attack.
- Organized crime could form an important nexus with WMD terrorism.

Other Major Conclusions and Unique Dimensions

The most unusual features of the study are: (1) the range of participants drawn in by the NIC, including corporate think tanks with strong reputations for futuristic analysis and foreign experts and agencies; and (2) the interactive features of the analytical methods, using specialist papers and conferences, and the iterative process of distilling results from highly diverse materials. Perhaps the most unique dimension of the study is the effort to project the future (or develop forecasts) qualitatively – in non-linear fashion.

Conclusions

The basic conclusions related to WMD are that further state and non-state spread of NBC and longer-range missile delivery capabilities, as well as some covert infiltration and delivery can be expected, and that novel BW agent development will accelerate and pose increasingly difficult biodefense problems. Terrorists probably will be most original, however, not in the technologies or weapons they employ but rather in their operational concepts–i.e., the scope, design, or support arrangements for attacks.

The Nuclear Tipping Point

Kurt M. Campbell, Robert J. Einhorn, and Mitchell B. Reiss, eds.
Washington, D.C.: Brookings Institution Press, 2004

Commissioned By
Funded by Carnegie Corporation of New York as a 3-year collaborative project between Reves Center of the College of William & Mary and the Center for Strategic and International Studies (CSIS) to examine factors in the international system that might trigger non-nuclear countries to reconsider their nuclear abstention, and the implications for the future of the nonproliferation regime.

Purpose and Objectives
The purpose of the study is to examine factors in the international system that might lead non-nuclear countries to reconsider their nuclear abstention and "go nuclear," and to explore the implications for the future viability of the nonproliferation regime. The eight states selected for the study, which are in good standing of the Nonproliferation Treaty (NPT), were assumed to represent a "barometer of the health of the international nonproliferation regime."

Timeframe Examined
The timeframes differed somewhat for each of the eight case studies. However, each of the case studies described the nuclear activities or interests of the countries concerned both in the Cold War period and also in the post- Cold War context. The projections of future behavior were for the foreseeable future in each case, but not specified as a precise timeframe.

Prevailing Context
The study was conducted between 2001 and 2004 with the impact of September 11, 2001 fresh in mind and amidst growing international concern about the erosion of the global nonproliferation regime and the possibility that a nuclear proliferation "tipping point" would be reached, bringing a cascade of new nuclear states.

Methodology
The study involved overviews of the history of international efforts to prevent nuclear proliferation in the early chapters of the book together with separate chapters on the historical analysis of eight countries in good standing under the NPT: Japan, South Korea, Taiwan, Saudi Arabia, Egypt, Syria, Turkey, and Germany. In each case study, the authors examined the historical reasons each country gave up its "nuclear option" and under what circumstances each might reconsider its position and take steps toward acquiring nuclear weapons or shortening the lead time to a nuclear weapon capability. The countries chosen for the case studies were selected because "they serve as a barometer of the health of the international nonproliferation regime and as an early warning system measuring the pressure

for independent nuclear arsenals." The study leaders who edited the book are experts on nuclear nonproliferation policy and each has held senior appointive positions in the U.S. Government. The country case studies were authored in most cases either by experts on the respective country or region, or experts who had significant USG service or American think tank experience with national security policy and nuclear nonproliferation policy.

Report Format

Part One: Nuclear Past and Present

1. The Nuclear Tipping Point: Prospects for a World of Many Nuclear Weapons States (Mitchell B. Reiss)
2. Reconsidering a Nuclear Future: Why Countries Might Cross over to the Other Side (Kurt M. Campbell)
3. Will the Abstainers Reconsider? Focusing on Individual Cases (Robert J. Einhorn)

Part Two: Case Studies

4. Egypt: Frustrated but Still on a Non-Nuclear Course (Robert J. Einhorn)
5. Syria: Can the Myth Be Maintained without Nukes (Ellen Laipson)
6. Saudi Arabia: The Calculations of Uncertainty (Thomas W. Lippman)
7. Turkey: Nuclear Choices Amongst Dangerous Neighbors (Leon Fuerth)
8. Germany: The Model Case, A Historical Imperative (Jenifer Mackby and Walter Slocombe)
9. Japan: Thinking the Unthinkable (Kurt M. Campbell and Tsuyoshi Sunohara)
10. South Korea: The Tyranny of Geography and the Vexations of History (Jonathan D. Pollack and Mitchell B. Reiss)
11. Taiwan's Hsin Chu Program: Deterrence, Abandonment, and Honor (Derek J. Mitchell)

Part Three: Prospects for a Nuclear Future

12. Avoiding the Nuclear Tipping Point: Concluding Observations (Kurt M. Campbell and Robert J. Einhorn)

Key Projections/Forecasts

The authors note five international and domestic factors that could potentially motivate a country to retreat from a "well-established non-nuclear identity" and move towards a latent or overt nuclear weapons capability:

1. An unfavorable or unwanted change in direction of U.S. foreign and security policy or a change in the perceived stability or credibility of the U.S. nuclear umbrella. Specific changes might include the umbrella drifting away from Germany by U.S. removal of its troops and assets from German soil, a U.S. retreat from a historic emphasis on the international nonproliferation regime, and the U.S. development of new nuclear weapons.

2. The breakdown of the nonproliferation regime caused by proliferating rogue states such as North Korea and Iran.

3. The erosion of regional or global security. For example, increased tensions between China and Japan could lead to Japan seeking to acquire a nuclear capability.

4. A decline in a state's domestic social condition. For example, seeking a nuclear capability may be one way in which a state may forestall vulnerabilities to economic and societal insecurities.

5. The increased availability of nuclear technology and potential sources of nuclear material. However the authors emphasize that "the potential availability of fissile material is unlikely to be the sole driver of a country's decision to go nuclear."

Specific forecasts

Egypt

The authors note that historically, Egypt was deemed likely to seek nuclear weapons due to regional fighting and a "cold peace" with neighbors who have nuclear capabilities. Additionally, Egypt flirted several times with civilian nuclear programs which could have potentially been used to develop military uses of nuclear technology.

The authors note that Egypt has pursued chemical weapons in cooperation with Iraq as well as purchased medium range missiles from North Korea. It is possible that these programs were pursued because of their cost-effectiveness when compared to developing nuclear weapons.

Additionally the authors note that no single event marked Egypt's decision to forgo nuclear weapons. However, they argue that strong U.S. relations are critical today for Egypt's continued renunciation as well as continued U.S. engagement in the Middle East peace process.

Syria

As a signatory of the NPT for over thirty years, Syria has been able to take little advantage of the many technical support services that the IAEA provided non-nuclear states. Syria's history with domestic nuclear activities began in 1976 with the establishment of the Atomic Energy Commission in Damascus. Throughout the 1980's Syria sought to negotiate deals to acquire nuclear power reactors, but in each case the proposed deals eventually went awry. Syria's first success came in 1991 with the purchase of a 30-kilowatt Chinese mini-reactor for research with no immediate military applications. In acquiring this reactor, Syria followed proper IAEA protocols. Syria sought to purchase an additional larger reactor from Argentina, but Argentina reportedly did not deliver due to pressures from the US. In 1998

Russia agreed to build one light water reactor in Syria but this project has not so far materialized.

The authors rate the possibility of Syria breaking with its non-nuclear commitment as quite low. However, factors which might lead Syria to decide to proceed down the nuclear path include:

1. National security requirements deriving from regional power imbalances.
2. The loss of status in the Middle East region because of other countries' nuclear advancements.
3. Rocky relations with the U.S. and the tendency in Syria to perceive the survival of its regime to be at stake.

Saudi Arabia

The chapter on Saudi Arabia suggested that Riyadh signed the NPT in 1988 primarily to placate the US. The authors also report that Saudi Arabia does not have the domestic technological capabilities to develop nuclear weapons and most analysts agree that Saudi Arabia has other concerns and is not interested in pursuing nuclear capabilities. However, the authors do report factors which may some day propel Saudi Arabia down the nuclear path.

1. There is no clear line of succession past Prince Sultan and a weakening economy might lead to domestic strife. Additionally, the Saudi military is reported as being well-equipped but poorly trained and possibly incapable of defending the country against an all out attack by Iran.
2. Though Saudi Arabia cooperates peacefully with Iran, Sunni/ Shiite tension is never far beneath the surface and if Tehran acquired nuclear weapons, Saudi Arabia may feel compelled to counter this threat.
3. If Saudi Arabia feels that it can no longer rely on U.S. security assurances, Riyadh may seek security through different avenues.

One possible scenario that may take place if Saudi Arabia decided to seek nuclear weapons is for Saudi Arabia to look to Pakistan. Some U.S. Government officials believe that Pakistan and Saudi Arabia have an understanding that Pakistani nukes would be made available to Saudi Arabia in extreme situations–guaranteed by Saudi funding of Pakistan's nuclear energy program.

Turkey

Though the collapse of the Soviet Union may have alleviated Turkey's most obvious incentive for seeking a nuclear capability, the authors point to six circumstances which might drive Turkey nevertheless to acquire nuclear capabilities.

1. An increase in insecurities surrounding a perceived decline in the credibility of NATO security guarantees.
2. The collapse of the international nonproliferation regime caused by the United State's failure to stop North Korea and Iran.

3. A strong shift in Turkish public opinion to reflect a more Islamic or nationalist orientation.
4. A revival of Russian expansionism.
5. The creation of a power vacuum in the Middle East.
6. Permanent damage to US-Turkish relations due to Turkey's unwillingness to substantially assist the United States with transit in 2003 during the outset of the Iraq war.

If Turkey was eventually to decide that its national security interests required nuclear weapons, it may pursue them under the auspices of a civilian nuclear energy program. To meet growing energy demands, Turkey's electric output must be doubled by 2010. However, five separate Turkish attempts to foster outside support for a civilian nuclear capacity in Turkey have all failed.

The authors conclude that any measure designed to enhance the credibility of NATO and the U.S. and EU as underwriters of Turkish national security would greatly diminish the risk of Turkey seeking nuclear weapons. A potential obstacle to the success of this approach is the continued spread of ballistic missiles throughout other parts of the Middle East.

Germany

Germany has formally committed to forgo the nuclear weapons option on three separate occasions since the end of World War II. The collapse of the Soviet Union and the fall of the Berlin Wall fundamentally changed Germany's strategic situation and almost eliminated entirely any perceived need for nuclear weapons. Even though Germany has always maintained a non-nuclear weapons status and policy, there is no doubt that Germany has the technical capability to quickly develop nuclear weapons and thus has a "virtual nuclear capability." The authors conclude that Germany is the clearest example of renunciation becoming a permanent national policy and they do not foresee any future developments that would shake this commitment.

Japan

Today Japan remains steadfast to its non-nuclear commitment despite the India-Pakistan nuclear tests as well as the North Korean flight of a Taepo Dong missile over Japan. However, the authors envision four situations in which Japan may reconsider the development of a nuclear capability.

1. An increase in the perceived security threat from North Korea.
2. The rise of Chinese strategic military power.
3. An inability or perceived inability of successive U.S. administrations to manage threats perceived by the Japanese as vital to their security.
4. The weakening of the international nonproliferation regime.

South Korea

Since the end of the Korean War, South Korea has responded to DPRK threats by three principal means:

1. Deterrence through a close alliance with the US.
2. The maintenance of a large conventional force.
3. Periodic diplomatic outreach to the DPRK.

There is no doubt that South Korea possesses an indigenous capability to develop nuclear weapons if and when it so chooses. South Korea has long pursued nuclear power as a means to address energy security. However, up to this point, South Korea as maintained that it is more viable to remain under the U.S. nuclear security umbrella than to develop indigenous capabilities.

The authors list several factors that could persuade South Korea to develop nuclear weapons despite the belief that that South Korea is intent on accommodation.

1. A major shift in the U.S. alliance.
2. A change in threat perception of North Korea.
3. The growing alignment with China.
4. The outcome of the North Korean nuclear crisis.
5. The aftermath of the political end to the Pyongyang regime.

Taiwan

The authors cite that the key constraints to Taiwan's pursuit of the nuclear option are political rather than technical. These constraints are:

1. Nuclearization would serve China as a justification for ending Taiwan's de facto independence by force.
2. Maintaining a secret weapons program is possible, but highly unlikely in modern Taiwan.
3. The U.S. is adamant about its opposition to any provocation from either China or Taiwan.

Finally, the authors cite two inducements which might persuade Taiwan to take the nuclear path.

1. A significant change in the security balance in the Straights and a perception that Taiwan can no longer count on U.S. security assurances.
2. A reduction in overall U.S. defense commitments to Taiwan.

Significant Points

The authors note five specific commonalties to each of the eight case studies:

1. The main motivating factor in deciding whether or not to acquire nuclear weapons was the state of the regional security environment. That is, states which saw a clear and present acute regional threat were more likely to consider the nuclear option.

2. U.S. foreign security policy has a significant effect on the "nuclear behavior" of countries as long as the U.S. nuclear security umbrella is perceived to be credible. The case studies show that the reliability and credibility of U.S. security assurances have played an important role in determining whether or not a state decides to seek nuclear weapons.
3. The perceived erosion of the international nonproliferation regime is a motivating factor when placed in concert with other factors that adversely affect a state's security.
4. Despite increased availability of critical nuclear technology, barriers to nuclear weapons are still quite formidable.
5. Democracy often does exert real constraints on the ability to pursue and acquire nuclear weapons. One exception to this rule in the selected case studies is Egypt. Egypt remains non-nuclear *because* it is not democratic. The authors posit that free elections in Egypt would make the country susceptible to populist movements which demand nuclear security.

Other Major Conclusions and Unique Dimensions

The study is unique in that it gives attention to the nuclear policies of states that have been stalwart in their observance of the NPT and non-nuclear commitments and to the conditions that could, if they materialize, cause one or more of these countries to reconsider their non-nuclear weapon commitments.

Conclusions

The authors make the following recommendations to increase the likelihood that countries committed to non-nuclear weapon status stay committed:

1. Stop Iran and North Korea from going nuclear.
2. Alleviate regional security concerns.
3. Raise barriers, both political and technological, to nuclear acquisition.
4. Strengthen verification, intelligence, and analytic capabilities.
5. Reduce the salience of nuclear weapons.

The Gathering Biological Warfare Storm

Jim A. Davis and Barry R. Schneider, eds.
Maxwell AFB: USAF Counterproliferation Center, 2002

Note
Consists of four assessments

1. The Prospects for Biological War in the Middle East

Brad Roberts

Purpose and Objectives
The author examines four primary questions to provide insight into the prospects for the use of biological weapons (BW) in the Middle East. The questions the author examines are:

1) How might BW be used in conflicts in the Middle East over the next decade?
2) How probable is such use?
3) By what rationales might certain types of targets be selected and concepts of operations (CONOPS) elaborated?

- What use scenarios stand out as of highest potential impact?

Timeframe Examined
2001-2010.

Prevailing Context
The context in which the forecast is conducted is in regard to increased proliferation of BW in the Middle East and especially the threat of Iraqi use of BW in Desert Storm.

Methodology
In addressing the above questions, the author focuses on the motivating factors that drove decision makers to seek acquisition of BW capabilities. However, the author makes a distinction between motivations to acquire and motivations to use– specifically noting that they are not one and the same.

A second approach the author cites is one that attempts to use the technical characteristics of BW to argue logically about the likely military applications. However, in the absence of hard data, the author notes that this is a highly speculative process and if it is to offer any real insights, it must be systematically employed.

Finally, the author approaches BW proliferation from both the perspective of the state and non-state actor. To illustrate the author's projections, one scenario is selected to provide a more in-depth analysis of how the motivations to acquire and/ or use BW could play out in the Middle East.

Report Format

I. General considerations on the motivations to acquire and/or use BW weapons.
II. A taxonomy of conflict in the Middle East which also uses a 1999 study to develop trends for "likely" future conflicts in the Middle East.
III. The likelihood that a future conflict will see the use of BW.
IV. Scenario entitled, *The Canonical Major Theatre War* which explores how, "a BW-armed regional aggressor use BW to commit and secure that aggression, and to cope with the political-military consequences of a U.S. effort to reverse that aggression."

Key Projections/Forecasts

Motivations to acquire

The motivations to acquire BW are underpinned by the kinds of conflict that are likely to occur in the Middle East region. The author presents nine potential categories of conflict and assigns his own views of the probability of conflict in each category:

1) Large-scale wars between states/regions are perceived to be unlikely.
2) There are likely to be limited interstate wars that do not call into question regime survival.
3) Acts of aggression by one state against another state in the region that bring U.S. involvement is likely. Also, Iranian coercion of GCC countries and/or Iranian attempts to disrupt the Strait of Hormuz are considered to be moderately likely.
4) Low-intensity conflicts raising questions of regime legitimacy and survival currently exist and will continue and may intensify.
5) Some regimes will be likely to violently suppress low-intensity conflicts (i.e., Iraqi suppression of the Kurds in the 1980's).
6) The emergence of splinter groups that violently oppose the Arab-Israeli peace process is likely.
7) State support for terrorism will continue on a constant path (same as before).
8) Transnational terrorism will not disappear from the region.
9) States and regimes will continue to place a high value on WMD as a "coin of power." WMD potential military utility is too powerful for most states and regimes to resist. Also, WMD possession will continue to be viewed as a status symbol of power, and can only help to reinforce the power of the ruling faction within the state.

Regions/countries of greatest concern

The author focuses on the Middle East region, especially Iran, Egypt, Syria, Israel, Libya, Lebanon, Afghanistan, and Turkey.

Deterrence and employment concepts

The above categories of conflicts and estimated likelihood serve as a vehicle to explore the potential use of BW. For example, the author predicts that the use of BW in anti-regime, low-intensity, conflict settings would prove too much of a destabilizing factor for the regime to consider BW a viable option. The loss of international support and risk of severe sanctions would be too great. The author also estimates the employment of a BW in a border-skirmish setting to be a low probability.

At the other end of the spectrum, the author posits that large interstate wars which threaten a regime's survival could legitimize a defending regime's use of BW. Further, BW use in asymmetric warfare against U.S. or U.S.-led intervention is also likely. Motivations of use for this scenario could include: coercion of the U.S. and allies, war fighting, escalation, and conflict termination. The author also describes international terrorists as a category of groups likely to use BW. The precedents the author cites are the established determination of known terrorist groups to acquire WMD and their demonstrated interest in mass casualties.

States that sponsor terrorist organizations have been hesitant to open their BW arsenals to the terrorist organizations they support. The author believes this is attributable to the regime's fear of retaliation against the state. The author's probing question, however, is: how much restraint will these states show in the future?

Specific forecasts

"The Canonical Major Theatre War" is the context in which the author forecasts how a BW-armed aggressor might use BW as a deterrent as well as a means of seeking to preclude or limit U.S. political-military efforts to reverse that aggression. Prior to the act of aggression, the aggressor is likely to attempt to isolate the U.S. by destabilizing U.S. allies. The potential use for BW at this pre-open war stage is unlikely; however, the author does note that the likelihood may rise if the aggressor has plausible deniability.

Once the aggressor acts, one of its primary goals will be to achieve decisive victory before any outside intervention. If the aggressor sees BW as useful or significant to the conflict, early use is likely. However, the aggressor's disincentives for use may include: increasing the odds of U.S. intervention, concerns over international backlash, and using BW when conventional weapons would work just as well.

If the aggressor fails to dissuade the U.S. from intervention by other means, BW may be used for their deterrent value. Additionally, the author notes that if BW were used for this purpose, then the aggressor may actually use the BW deliberately against civilian targets to serve as a warning against further U.S. action. If deterrence fails, the aggressor's interests in use of BW probably will shift to military strikes intended to cripple U.S. intervention. The use of BW in this scenario is quite high.

Finally, if the aggressor fails to defeat the U.S., the aggressor may use BW as last resort to prevent strategic defeat in terms of military dismemberment.

Other Major Conclusions and Unique Dimensions
The author focuses on the motivations to use BW militarily and politically, and not only on the motivations to acquire BW.

Conclusions
The author concludes that the context of the "canonical major theatre war" stands out as potentially the richest in insights for understanding the future role of BW in the Middle East. Finally, the author raises the question of how a potential BW attack would be prevented or defeated by, for example, detecting the delivery systems and/or protecting against the biological agent. In such scenarios, the author raises the question of how such a failed attack with WMD would reshape security relations with the U.S.

2. Assessment of the Emerging Biocruise Threat

Rex R. Kiziah

Purpose and Objectives
This chapter focuses "on a subset of the growing threat of cruise missiles (CM)," and evaluates the prospects for "rogue nation acquisition and use of land-attack cruise missiles (LACM) to deliver BW agents against future U.S. military operations in regional conflictions around the world and also against military and civilian targets within the United States and allied countries." The author seeks to answer the question of how likely a rogue state is to employ cruise missiles with BW agents against the U.S. beyond 2005.

Timeframe Examined
2005 and beyond.

Prevailing Context
The author's paper was conducted in light of a prevailing Western use, and the regional proliferation of cruise missiles and cruise missile technology over the past two decades. LACMs have become a centerpiece of the U.S. military inventory and their use has expanded dramatically since the Gulf War. However, advances in technology have made LACM acquisition a real possibility also for rogue nations. In 1999, much discussion revolved around the proliferation of cruise missiles to rogue nations such as Iran, Iraq, and North Korea.

Methodology
The author uses a trend analysis of cruise missile technology and acquisition to predict future likelihoods of nations using LACMs equipped with BW agents.

Report Format

I. General Considerations of LACM proliferation and use (both by U.S. and rogue nations).
II. Motivations behind rogue state acquisition of BW and an assessment of their BW programs.
III. A look at the technical characteristics of LACMs and those attributes which make them desirable as a delivery platform for BW.
IV. Examination of proliferation pathways that rogue states could potentially use for acquisition of LACMs and to arm them with WMD.
V. An overall assessment of how likely rogue states will be able to employ cruise missiles to deliver BW agents.

Key Projections/Forecasts

Motivations to acquire

The author lists four key motives for acquisition:

1) For use as military and economic levers of strategic power: The author cites this as the most compelling reason a rogue state would acquire a CM with BW in a post-Cold War era–that is, deter, constrain, and harm the U.S. He concludes that because in the near term rogue states are unlikely to be able to compete with the U.S. on conventional military terms, they will perceive they can level the playing field with WMDs such as BW.
2) Technology and WMD proliferation. It is easier now to acquire CM than ever before. Exacerbating the problem is the willingness of other countries to provide WMD delivery systems by direct sale.
3) Difficulties deterring WMD use. Another trend that enhances a rogue state's desire to acquire WMD is the contemporary erosion of inhibitions on WMD use. For example, Saddam Hussain's Iraq has already demonstrated willingness to use WMD on the battlefield and against its own people. Also, deterrence relies on retaliation–which in turn relies on knowing who launched the attack. It is possible to use LACMs to deliver BW without the attacked state necessarily knowing the origin of the attack.
4) National prestige. Some regimes in developing countries view the possession of WMDs as a status symbol that ushers them into the company of the great powers.

The author also underlines the appeal of BW to potential proliferators by highlighting their characteristics, and thus their nature as serious proliferation concerns:

1) Can cause a large number of casualties. The author argues that BW provide "more bang for the buck," they are cheap to make and easy to deliver.
2) Economically and technically attractive. That is, BW are more easily made available than nuclear or chemical weapons. Also, almost all of technology required for a BW program is dual-use technology and thus available from a variety of legitimate enterprises.

3) Clandestine acquisition. BW programs can be disguised as legitimate research.
4) Clandestine use. There are no reliable detection devices available that provide advanced warnings of a BW attack. Also, the origin of a BW can be easily masked.

Regions/countries of greatest concern

Iran

Iran's BW efforts are part of an overall campaign to become the dominant power in the Middle East. Iranian leaders view WMD and means of delivery as essential to Iran's overall security and military requirements. Also, the Iranians are known to have hired Russian, Chinese, and North Korean BW experts.

Iraq

Iraq has precedents for using WMD. Also, it was discovered that during Desert Storm, Iraq had 166 bombs, 25 Scud missiles, 122mm rockets, and fighter aircraft equipped with spray tanks–all of which were filled with BW agents.

Libya

A 1997 report suggested that Libya was seeking BW and may have a limited capability to already produce weaponized BW agents.

North Korea

North Korea has been conducting BW research since the 1960's and is likely to already have a capability that is equal to, or greater than Iraq's.

Syria

Syria has strong motivations to acquire BW because it views Israel as an "aggressive and expansionist state." Syria could view BW as a deterrent to Israel's nuclear capabilities.

Specific weapon types (N, B, C, R, Delivery Means), to include new or non-traditional weapons/effects/production techniques/delivery means

The study solely addresses land-attack cruise missiles (LACMs) as a delivery vehicle type for biological weapons.

Acquisition patterns/trends

The author cites three major proliferation pathways that are likely to be used by rogue states:

1) Direct purchase. The author deems this method as the quickest and most direct path to CM acquisition. The author projects that within the next decade, the number of state CM producers will increase from two to nine. Many countries such as France and Russia will most likely make their LACMs available for export and sales could reach as high as 6000-7000 by 2015, excluding U.S., Russian, and Chinese sales.

2) Indigenous development. This is the most lengthy and technically difficult path. However, factors which are making this pathway more likely are developments in technology which ultimately make LACM components cheaper and easily available on the open market.
3) Conversion of Air-to-Surface Cruise Missiles (ASCMs) to LACMs. Rogue states and lesser developed countries are likely to convert the large number of ASCMs they possess (approximately 75,000 have proliferated throughout the world).

Specific forecasts

Though the author does not make specific forecasts in a traditional sense, his trend analysis and conclusions lead the reader to believe that biocruise missiles present a real threat to U.S. and international security and the proliferation of biocruise missiles should be a primary concern.

Other Major Conclusions and Unique Dimensions

The author concludes with a summary and assessment of the biocruise missile threat, stating that it is now easier than ever for rogue states to acquire cruise missile technology which can easily be equipped with BW. Also, the author is quick to point out that rogue nation capabilities will likely emerge quickly and with little if any warning.

3. Next Generation Bioweapons: Genetic Engineering and Biological Warfare

Michael Ainscough

Purpose and Objectives

The purpose of this chapter is twofold: to consolidate accounts of genetic engineering from sources close to the former Soviet Union (FSU), and discuss near term future capabilities of genetic engineering and biowarfare from a U.S. perspective.

Timeframe Examined

The projections the author makes are not limited to a specific timeframe, but are in the context of the "near future."

Prevailing Context

No discernable context can be determined. However, the trend analysis that the author uses is taken from the account of fairly recent FSU defectors who revealed information regarding advanced Soviet BW programs.

Methodology
The author uses the accounts of FSU scientists to substantiate projections about the future of BW.

Report Format
I. Description of the FSU BW program and testimony from FSU defectors.
II. Scientific reports of genetic advancement and their implications.
III. Pathways that enhance biothreats
IV. Pathways that can enhance biodefence

Key Projections/Forecasts
Acquisition patterns/trends
According to FSU defectors, the FSU:
1) genetically engineered bacteria and viruses;
2) weaponized microbes in powder form;
3) loaded microbes onto various munitions;
4) integrated BW into doctrine;
5) continued secret research on new forms of plague even after President Yeltsin terminated the program;
6) possessed fifty-two different biological agents engineered as "battle-strains"; and,
7) shared BW knowledge with other states including, Iran, Iraq, India, Cuba, and Eastern Europe.

The author specifically noted that since the FSU classified their BW as "special information" (higher than Top Secret), it is clear that the FSU valued their BW missiles as equally as their nuclear missiles.

Specific forecasts
- The author predicts that biotechnology will contribute to a future revolution in military affairs. That is, the same techniques that are being used to enhance genes and create resistances to harmful bioagents, can be just as easily adapted to a military setting.
- BW will always be viewed as advantageous to the state looking for asymmetric warfare.
- Terrorist organizations will likely seek BW to use against civilian populations. If such BW are used, it would likely take a fair amount of time to determine whether the attack was that of an aggressor or naturally occurring.

BW use will create tremendous attribution problems for the attacked state and an enormous advantage to the aggressor.

Significant Points

The author cites six broad categories in which the biothreat could potentially be enhanced:

1) Binary biological weapons (i.e., enhancing pathogenic bacteria with plasmids);
2) Designer genes;
3) Weaponized gene therapy;
4) Stealth viruses (i.e., viruses that remain dormant until an external stimuli activate them);
5) Host-swapping diseases (i.e., viruses that can cross infect humans and animals); and,
6) Designer diseases.

To counter the biothreat, the author cites six areas which could potentially improve biodefense:

1) Understanding the human genome;
2) Boosting the immune system;
3) Understanding viral and bacterial genomes;
4) Rapid and accurate bio-agent detection;
5) New vaccines; and,
6) New antibiotic and antiviral drugs.

Other Major Conclusions and Unique Dimensions

None that are discernable.

Conclusions

The author concludes that engineered pathogens will be the "next generation" of biological warfare agents. The author states, "Although biologically engineered weapons may currently be less of a concern than their naturally occurring counterparts, the threat they pose can only increase as technology develops."

Additionally, the author predicts that even though the use of BW against the U.S. to date has been restrained, this benign condition is likely to be disrupted as rogue states begin to view BW as a viable means of pursuing their objectives.

4. A Biological Warfare Wake-Up Call: Prevalent Myths and Likely Scenarios

Jim A. Davis

Purpose and Objectives
The purpose the author's study is to examine the nation's vulnerability to BW by illustrating three of the most likely scenarios the U.S. may face. Ultimately, it is the objective of the author to identify the areas where the U.S. can best spend dollars and create a coherent national plan to prepare for BW attack.

Timeframe Examined
The scenarios that the author presents have the potential to occur at any point in time.

Prevailing Context
There is no discernable prevailing context to the study other than the general perception of BW as a great threat to the security of the U.S.

Methodology
The author uses motivations for a BW attack against the U.S. to develop the three most likely BW attack scenarios. The scenarios are:

1) The Agroterrorist Scenario;
2) BW Attack on U.S. or allied forces in the Middle East; and,
3) A Large Bioterrorist attack on a large U.S. or allied population center.

Report Format

I. Six myths as to why people do not believe a mass casualty attack will occur.
II. Possible motivations for a BW attack.
III. Possible Future BW scenarios

Key Projections/Forecasts
Motivations to acquire
The author cites four motivations that might drive an adversary to attack the U.S. with a BW:

1) To gradually erode U.S. influence as a world superpower.
2) The desire to reduce the U.S. as a competitor.
3) Religious differences may motivate an attack.
4) Envy, rage, or hatred against the U.S.

Specific forecasts

- Scenario A - The Agroterrorist Scenario: In the agroterrorist scenario, the moral barriers to using BW are quickly overcome. Inflicting damage to U.S. agriculture could cause the U.S. economy to become chaotic. The 2001 foot and mouth outbreak in Britain is estimated to have cost $30 to $60 billion in clean up and recovery. Also, one of the benefits of this type of attack is that the aggressor may

never be identified. A drawback is that such an attack might take years to accomplish the end goals.

- Scenario B - BW Attacks on Forces in the Middle East: The goal of this attack would be to force the U.S. to withdraw military forces from the region. One option is use a non-lethal BW agent to cause mass sickness. Again, it would be possible for the perpetrator to avoid detection and retaliation from the U.S. Another option would be for the adversary to make the U.S. look responsible for an attack, such as releasing agents downwind from the U.S. base. This type of attack could be used to create tension between the U.S. and host nation. Finally, the aggressor could use a small amount of BW agent to kill Americans as a warning of possible, larger future attacks.
- Scenario C - A Bioterrorist Attack on a Large U.S. or Allied Center: Similar to the 9/11 attacks, such a BW attack would take place in several major U.S. cities at once. The perpetrators could easily depart the country before onset of symptoms. If anthrax were used as the BW agent and the conditions were right, hundreds of thousands of people would potentially be infected and die.

Significant Points

The author points out six beliefs that explain why individuals do not think a mass casualty BW attack is imminent:

1) *There never really has been a significant BW attack.* According to the author, this blatantly contradicts historical facts, citing examples such as plague used by Mongols in 1346, anthrax used by the Germans in WWI against allied horses and mules, Japanese use of typhoid in WWII, and the anthrax attack on U.S. government offices in 2001.
2) *The U.S. has never been attacked by a BW agent.* Two counter-examples that the author cites are the 2001 anthrax attacks and the Bhagwan Shree Rajneesh cult contamination of 10 restaurant salad bars.
3) *You have to be extremely intelligent, highly educated, and well funded to grow, weaponize, and employ a BW agent.* A group's financial status or brilliance is no longer a significant roadblock to BW agent acquisition. According to recent reports from the Johns Hopkins University, BW agent acquisition has probably already crossed over from "too difficult" to "doable."
4) *Biological warfare must be too difficulty because, when it has been tried, it has failed.* Not true, the author notes, since all of the previously mentioned attacks have resulted in deaths.
5) *There are moral restraints that have kept, and will keep, BW agents from being used.* Past history does not validate this argument. However, the author cites 9/11 and other mass casualty attacks as evidence that the previous moral constraints are no longer applicable.
6) *The long incubation period required for BW agents before onset of symptoms makes BW useless to users.* This reasoning does not negate the use of BW as a weapon of terror.

Other Major Conclusions and Unique Dimensions

The author concludes that despite the 9/11 attacks and the anthrax attack shortly afterwards, many decision makers do not believe a BW attack on the United States will happen in the next ten years. Noting that the counterterrorism effort is under funded, the author suggests that billions of extra dollars be invested in upgrading the protection of the U.S. agricultural industry.

Global Evolutions and the Role of Nuclear Weapons: Alternative Futures for the Next Decade

Daniel J. Whiteneck
In NIC 2020 Project. Washington, D.C.
The CNA Corporation, 2004

Commissioned By

The study was conducted by the CNA Corporation as part of the National Intelligence Council's 2020 project.

Purpose and Objectives

The purpose of the study is to present three alternate scenarios based on six global trends. The six trends are framed in a context of an increasingly complex global system. In each of the three alternative scenarios, the author describes the role of the U.S. and its allies' nuclear arsenals in a world of increased rivalry and regional competition. The author's stated objective is not to suggest a particular policy, "…but to illuminate the potential directions of the evolving global system, and the choices those directions impose on nuclear weapons policy decision makers in the United States and its allies."

Timeframe Examined

2004 to 2014 (ten years).

Prevailing Context

The prevailing context of the study is world of increased political, economic, social, and military globalization. Additionally, the author emphasizes the role of the rogue-state and non-state actor in nuclear proliferation.

Methodology

The methodology used was a qualitative analysis by non-government experts based on six identified global trends.

Report Format

The author first presents the current "state of play" in terms of global trends applicable to forecasting nuclear proliferation. In summary, these trends are: the increasing gap between globalization of economic interactions and the localization of political interactions, the erosion of nation-state sovereignty by international organizations as well as regional enterprises, increased democratic "revolutions" in the global community, the diffusion of technology continues to increase, the "Americanization" of global culture continues to make positive and negative impacts, and finally a single military superpower with dominant forces of global reach continues to exist. Next, each of the three alternatives is characterized and projected as possible outcomes over the next ten years. The author termed these alternate futures as: the cooperative future, the competitive future, and the chaotic future. The main

discussion of the author attempts to postulate the role of nuclear weapons in each of the three alternate scenarios.

Key Projections/Forecasts

The Competitive Future

In the competitive future, the U.S. would most likely retain a nuclear arsenal that resembles its past structures. Additionally, the U.S. nuclear arsenal would rely on a traditional triad to ensure a strategic deterrent. The author predicts in this scenario, however, that the nuclear forces of other states would be much smaller. In regards to nuclear testing, the author suggests that opposing states in this competitive scenario could potentially resume nuclear testing to ensure weapons reliability as they built deterrents against the U.S. In this case, nuclear weapons would serve as a break on "great power confrontations" and thus, "would return nuclear weapons to a central role for the U.S. and other states as a measure of great power position."

The Chaotic Future

In the chaotic future, the author posits that the U.S. would change its nuclear posture to target WMD-related facilities and delivery systems of rogue states. Additionally, in this scenario, terrorist organizations and leaders would also be targeted if evidence existed of their WMD development or their planned attacks. U.S. nuclear forces would be smaller overall and with more emphasis on tactical strike capabilities. The development of these types of tactical strike weapons would most likely result in the failure of the CTBT as other states followed suit.

The Cooperative Future

The cooperative future presents the greatest challenge to the currently planned posture of the U.S. nuclear weapons arsenal. The author asks, "How would the need for robust nuclear forces be explained, what would such a force look like, and what rationale would be offered for targeting policies or the resumption of testing?" In such a scenario, there would be no compelling rationale for the U.S. to adhere to the CTBT. Such an action would run the risk of the resumption of testing by other states and sparking a new round of proliferation. The size of the U.S. nuclear arsenal in the cooperative scenario would likely be much smaller as well as the reserve stockpiles. According to the author, the rationale for maintaining a nuclear arsenal would be based on maintaining U.S. hegemony.

Other Major Conclusions and Unique Dimensions

According to the author, global trends are directing the world more toward the cooperative future scenario than the alternatives. Though the global trends do not conclusively lead to the cooperative future, the author predicts it is the most likely path for politics in the next decade. Global trends that have lead the author to make this assertion, have been the increased concerted action among the great powers to address critical issues. These concerted actions include the development and implementation of cooperative measures of the G7, OECD, and IMF to address: global economic problems, global security threats from

rogue states which have decreased, global terrorism which has been set back by collective military and police action, the need for collective actions of the UN, NATO, and other alliances which have involved the U.S. and its allies in many peacekeeping and nation building efforts, and finally, the fact that the U.S. and Europe have worked cooperatively to address security issues around the world.

The "potential surprise" factor in the cooperative future is the possible proliferation of nuclear weapons to rogue states or terrorist groups. Thus, one of the chief concerns for the viability of this cooperative scenario would be the prevention of the spread of technology or finished weapons from various sources to the rogue states or terrorist groups.

Finally, the study predicts that by 2020, the NSG, CTR, and IAEA could form the core of a better nonproliferation regime, "…and the number of nuclear powers could be at no more than ten."

Deadly Arsenals: Nuclear, Biological, and Chemical Threats

Joseph Cirincione, Jon Wolfsthal, and Miriam Rajkumar, eds.
Second ed. Washington, D.C.
Carnegie Endowment for International Peace, 2005

Commissioned By
Carnegie Endowment for International Peace, Washington, D.C.

Purpose and Objectives
To produce the most complete and authoritative resource available from unclassified sources on the spread of nuclear, chemical, and biological weapons and their means of delivery.

Timeframe Examined
1998-2005, with some limited forecasts into near future based on existing trends.

Prevailing Context
Key events bearing on WMD proliferation between the 2002 edition and the second edition in 2005 were the attack of 9/11 (bringing threat of non-state actors to top of agenda), the post-Iraq War discoveries of intelligence misjudgments on WMD capabilities in Iraq, North Korea's violation of its nuclear nonproliferation commitments and withdrawal from the NPT, the disclosures in 2003 of the A. Q. Khan network, information on the acceleration of Iran's nuclear weapons program, and the success story of Libya dismantling its clandestine nuclear and chemical weapons capabilities.

Methodology
The methodology used was essentially the same qualitative, policy-oriented analysis based on compilations of open source data on national programs and capabilities (by a small team of experts at Carnegie and help from consultants) as that of the *Tracking Nuclear Proliferation* predecessor study, (see methodology paragraph in its assessment). But *Deadly Arsenals* expanded the scope of its study to include the arsenals of the Western nuclear powers, the United States itself, and the United Kingdom and France, rather than restricting the study to "countries of concern" in the usual U.S. national security policy perspective. In the 2005 edition, the authors of *Deadly Arsenals* dropped the terminology of WMD and addressed nuclear, biological, chemical, and radiological weapons capabilities separately, arguing that the term WMD "conflates very different threats from weapons that differ greatly in lethality, consequence of use, and the availability of measures that can protect against them," so that "failure to differentiate these threats can lead to seriously flawed policy."

Deadly Arsenals reports almost exclusively on the current status of programs and only episodically provides forecasts or projections. It also advocates policy changes in the form of a "universal compliance" framework and suggests that such policy changes, if adopted, would limit proliferation trends and, implicitly, alter forecasts. The study is a mix of

optimism and pessimism. On the optimistic side, it suggests that many cases of historical proliferation have been reversed, limiting the number of countries of real concern to a handful.

With respect to CW and BW programs and capabilities, this study appears to be almost an afterthought. It relies heavily on unclassified or media-reported U.S. intelligence statements as sources and to a lesser extent on reported CWC-compliance-required disclosures; it contains little independent information or analysis of CW/BW in the country case studies and the CW/BW treatment has relatively little depth.

Report Format

The format of this book is indicated by its table of contents, in 5 parts and 21 chapters, as follows:

Part One: Assessments and Weapons

1. Global Trends
2. The International Nonproliferation Regime
3. Nuclear Weapons and Materials
4. Biological and Chemical Weapons, Agents, and Proliferation
5. Missile Proliferation

Part Two: Declared Nuclear Weapon States

6. Russia
7. China
8. France
9. United Kingdom
10. United States

Part Three: Non-NPT Nuclear Weapon States

11. India
12. Pakistan
13. Israel

Part Four: Two Hard Cases

14. North Korea
15. Iran

Part Five: Nonproliferation Successes

16. Libya
17. Iraq
18. Non-Russian Nuclear Successor States: Belarus, Kazakhstan, and Ukraine
19. Argentina
20. Brazil
21. South Africa

Key Projections/Forecasts

Motivations to acquire

- Treatment of motivations is uneven, explicit and sometimes extensive on the countries mentioned immediately below, but not addressed explicitly or systematically in most cases.
- India's motives for developing and demonstrating nuclear weapons were primarily to achieve strategic autonomy and symbols of power that would confer status, but Indian officials also cited China (and its strategic cooperation with Pakistan) as a threat requiring that India acquire a strategic counter-capability.
- Pakistan's motives for developing and demonstrating nuclear weapons centered largely on perceived Indian threats to its security and fears of Indian military dominance.
- Israel's motives for acquiring a nuclear arsenal were the belief of key leaders that a nuclear deterrent was vital for the small nation's survival in a region filled with large enemy states.
- Iran's motives for unconventional weapons and missile delivery systems are attributed to its size, location, history, and sense of self-importance, its aspiration to become the region's major power, its wartime experience with Iraq (in which CW and ballistic missiles were used), and perceived value of such weapons in deterring U.S. military action in the Persian Gulf. Iranian officials probably have been influence also by Israeli, Pakistani, and Indian possession of nuclear weapons.

Regions/countries of greatest concern

- Europe: Russia
- East Asia: China, North Korea
- South Asia: India, Pakistan
- Middle East: Egypt, Iran, Iraq, Israel, Libya, Syria

Specific weapon types (N, B, C, R, Delivery Means), to include new or non-traditional weapons/effects/production techniques/delivery means

- 8 countries with nuclear arsenals: Russia, China, USA, United Kingdom, France, Israel, India and Pakistan.
- 2 countries with *suspected* nuclear weapon programs: Iran, North Korea.
- 7 countries *suspected* of retaining biological weapons or BW programs: Russia, China, Egypt, Iran, Israel, North Korea, and Syria.
- Countries that *declared* possession of chemical weapons or of former CW programs or facilities but made commitments to eliminate stockpiles and programs: Albania, Bosnia, China, France, India, Iran, Japan, Libya, Russia, South Korea, the United Kingdom, the United States, and Yugoslavia. (The authors note that Iraq's program was dismantled under UN sanctions.)
- 7 countries *suspected* of retaining national CW programs: China, Egypt, Iran, Israel, North Korea, and Syria.

- 5 countries with ICBMs: Russia, China, France, the United Kingdom, and the United States.
- 1 country with IRBMs (3,000-5,500 km range): China.
- 7 countries with MRBMs (1,000-3,000 km range): China, India, Iran, Israel, North Korea, Pakistan, and Saudi Arabia. *The authors consider these seven countries and their MRBM programs, together with Russian missile technology exports, to be the ballistic missile programs of greatest proliferation concern.*
- 19 countries with *only* SRBMs (range less than 1,000 km): Afghanistan, Armenia, Bahrain, Belarus, Egypt, Greece, Iraq, Kazakhstan, Libya, Slovakia, South Korea, Syria, Taiwan, Turkey, Turkmenistan, Ukraine, United Arab Emirates, Vietnam, and Yemen.

Acquisition patterns/trends

India

The country's space, ballistic missile and cruise missile programs have received critical technology from the United States, France, Germany, the former Soviet Union/Russia, and Israel. India's closely-related SLV program has inherent ICBM capability.

Pakistan

Pakistan's ballistic missile capabilities were acquired primarily from China (until 2001) and North Korea.

Israel

The nation was secretly assisted by France in developing nuclear capabilities has been a de facto nuclear weapons state since the late 1960s. For nuclear delivery purposes, in addition to fighter-bomber aircraft, Israel has deployed MRBMs and, more recently, has acquired a fleet of Dolphin-class submarines from Germany and modified U.S.-supplied Harpoon missiles for use with nuclear warheads – the basis of a second-strike capability. Israel reportedly also has developed air- and ground-launched cruise missiles, reportedly with Chinese assistance, as well as its own UAVs. Israel also has active missile defense capabilities in the Arrow and is cooperating with the U.S. on laser-based anti-rocket defenses.

Iran

Iran's acquisition of nuclear technology has long depended almost entirely on outside suppliers, including several countries in Western Europe, Russia, and China. Disclosures in January 2004 revealed that the A.Q. Khan network had made gas-centrifuge enrichment technology available to Iran together with a list of suppliers of essential equipment. Iran's missile programs depended primarily on exports of technology, components, production equipment, and training by Russia, China and North Korea.

Iraq

The country's former nuclear weapons program infrastructure and chemical and biological stockpiles and production infrastructure, and the production capability and stocks of ballistic missiles with ranges greater than 150 kilometers, were largely destroyed either during the bombing of the 1991 Gulf War or by the IAEA and UNMOVIC inspectors and dismantlement teams in the mid-1990s. These efforts are described in the Iraq chapter in some detail.

Deterrence and employment concepts

India claimed a minimum nuclear deterrence posture of no-first use (NFU) but readiness to use massive retaliation if the country is attacked with nuclear weapons, and would suspend NFU if its military forces are attacked with CW or BW. Despite a range of nuclear-capable aircraft and development, testing, and limited production of a wide range of nuclear-capable ballistic and cruise missiles, the deployment status of India's nuclear weapons is considered to be ambiguous although nuclear-capable missiles have been integrated in certain Army units.

Pakistan had not enunciated an explicit nuclear posture but former officials indicated it could be considered one of credible minimum nuclear deterrence. Like India, Pakistan disclaimed deployment of nuclear forces, and also like India, put certain nuclear-capable ballistic missiles into active service with specific Army units.

Areas for potential surprise

- The likelihood that the full extent of A.Q. Khan's network and the nuclear black market has not been uncovered.
- Hard evidence (not publicly available at that time) that North Korea had successfully developed and assembled a small stockpile of nuclear weapons. (North Korea tested a nuclear device in October 2006.)

Specific forecasts

1. Overall the ballistic missile threat is limited and changing slowly.
2. The danger of nuclear weapons acquisition by Iran or North Korea is not that either would likely use these weapons to attack the United States, Europe, or other countries. They will be deterred by the certainty of swift and massive retaliation. The greatest danger is the reaction of other states in the region, setting off a ripple of weapons decisions and wider proliferation. That in turn could lead to regional wars and eventually to nuclear catastrophes.
3. The long-standing conflict between India and Pakistan, and their nuclear arming, has made South Asia the region most likely to experience the first use of nuclear weapons since 1945.
4. Miscalculation or misunderstanding could bring nuclear war to the Korean peninsula.

5. In the Middle East, Iran's nuclear program together with Israel's nuclear arsenal and the chemical weapons of other neighboring states would increase the volatility of this conflict-prone region. Iranian acquisition of nuclear weapons could cause Egypt, Saudi Arabia, or others to start or revive nuclear weapons programs. Thus, this region could go from a region with one nuclear state to two, three, or five such states – within a decade.
6. Many years will be required before India has a test-proven (ICBM) capability to carry nuclear weapons to ranges of 5,500 kilometers or more.
7. It is unlikely that Israel will follow India and Pakistan's examples of declaring nuclear weapons status, and give up its policy of ambiguity – unless Iran's nuclear ambitions trigger such a change.

Significant Points

- The study gives high priority to assessment of nuclear capabilities and provides a meaningful basis for differentiating the various types and consequences of WMD for threat assessment and policy response.
- The study has an elaborate dissection of the post-war findings regarding Saddam Hussein's WMD programs, based on reports by inspectors on the ground after the March 2003 invasion of Iraq.

Other Major Conclusions and Unique Dimensions

A distinct dimension of this study is that by including the Western nuclear powers it suggests that their nuclear and WMD capabilities are part of the overall WMD proliferation problem in a fashion that is not customary for standard forecasts and projections of national security threats to the United States.

Conclusions

This study does not have a set of conclusions as such. Its broader conclusions tend to be interwoven in the introductory overviews and the more specific conclusions are in the case studies – usually taking the form of current status reporting. Its broader conclusions put considerable emphasis on past nonproliferation successes. The study is seriously absorbed in the two chapters pertaining to North Korea and Iran with the WMD problems each poses, but its treatment of the range of countries of concern on balance suggests that the proliferation problems – although serious, and potentially worsening – are not as serious as claimed by some USG agencies and defense experts, and could be brought under control with a concerted strategy that observes the principle of *universal compliance* and that combines diplomatic and international instruments with military and security approaches.

The Changing Face of Proliferation: Some Thoughts, Speculations, and Provocations

Lewis A. Dunn
In CSIS-Sandia Workshop on Changing Face of Proliferation, 2005

Commissioned By
Sandia National Lab and the Center for Strategic and International Studies

Purpose and Objectives
To help provoke discussion of how the NBC proliferation problem could change in the next decades.

Timeframe Examined
2005-2050 (next several decades)

Context
No specific indication of major events. The author notes that the key characteristics of proliferation have changed repeatedly over the past decades, sometimes for the better, sometimes for the worse, but often surprisingly.

Methodology
The paper is a thought piece that seeks to anticipate how NBC proliferation may change by breaking down the problem into its different parts, asking what factors could "drive" and "shape" future NBC proliferation, and discussing the next use of NBC weapons, particularly the consequences to the next user. The approach adopted is intentionally free-wheeling and kaleidoscopic, if not idiosyncratic. It is not a research monograph, but rather a speculative inquiry that reflects over thirty years of thinking about and working with proliferation issues both inside and outside the government.

Report Format
The paper is organized to look successively at descriptive categories that are named to illuminate the "changing face" of proliferation. The author's forecasts regarding proliferation are woven into the categories, which are neither mutually exclusive nor are events or trends in one category independent of events or trends in another. But the very nature of the chosen descriptors is a forecast of what may be the most salient and important features of the future of proliferation for which to anticipate and prepare. The treatment of the descriptors also allows for twists and turns, including the possibility of moving away from nuclear or WMD proliferation.

I. The "Who" of Future Proliferation

The "Who" – the Nation-States:

The Usual Suspects

The Reformed Proliferators
The Status Seekers
The Tough-Minded Independents
The Reluctant Non-Proliferators
The Newly Threatened Good Guys
The New Global Powers
Not the Last and Not the Least
The Renunciationists

The "Who" – the Non-State Entities

Islamist Revivalist-Restorationists
The Islamic Freelancers
Apocalyptic Movements
National Liberationists-Rebels, Home Grown Extremists, and Criminal Organizations
Coup-Makers

II. The "What" of Future Proliferation

The "What" – the States

Nuclear First and Foremost – Barring…
- Threat Perception
- Perceived Deterrent Utility
- Perceived Potential Coercive Utility
- Relatively Greater Status and Prestige
- But Some Caveats…
  - Disastrous Use
  - Events Get out of Control
  - Radical Nuclear Revisionism
  - The Fact of Non-Use

Chemical Weapons – Drifting Downward?
- Perceived Relative Utility
- Changed U.S. Chemical Weapons (CW) Defense Capabilities
- Less Fit with the "Whos"
- But Some Caveats Again …
  - New CW Options
  - CW Use All Over Again

Biological Weapons – Treading Water until…?
- Plausible but Unproven Utility
- Proven Low Deterrent Value v. the United States
- Relative Ease of Production
- Shifting Balance of Offense-Defense
- A Few Caveats or Wild Cards
  - First Use
  - Response to First Use

- Lethal Biological Weapons (BW) to Buy Time – for Nuclear?
- Lessons of Terrorist BW Use

Missile Proliferation – Shifting Directions

- Product Improvement and Upgrades
- Shifting Directions
- Rusting Relics, or What if BMD Works – and Spreads?

The What – Non-State Entities

Al-Qaeda: Harbinger or Outlier?

Isolated Development or Routine Phenomenon?

III. The "Why" of Future Proliferation

The "Why" – the States

The Why of ***Explosive*** State Nuclear Proliferation

- Lack of Proliferation Firebreaks
- Erosion of Structures, Norms, and Institutions
  - U.S. Security Structures
  - The NPT Factor
  - Successful Use
- Changing Leadership Beliefs and Psychology
  - Hedging Bets
  - Reduced Supplier Cooperation
- Globalization – and Increasing Technical Opportunity
- Latent Capabilities in Key "Proliferation Spark-Plug" Countries
- Successful Use – the Key Trigger?

The "Why" – the Non-State Entities

The "Why" of Non-State Proliferation

- The Islamic Revivalist-Restorationists – Use but…?
  - The Record
  - Visually-Pleasing Destruction
  - Too Valuable to Detonate?
  - Fit with the Islamist Revivalist-Restorationists Goal?
- The Islamist Freelancers
- The Apocalyptic Movements
- National Liberationists and the Other Non-State Entities
  - National Liberationist-Rebels
  - Home Grown Extremists
  - Criminal Organizations
- The Coup-Makers

IV. The "How" of Future Proliferation

The "How" – the States

The Traditional "Tried and True" – Do it Yourself

- Back to "Openness" – Ever?
- Surge Bio Capability – or Capabilities in Being?
- The Right People

Getting By with Some Help from Friends
More A.Q. Khans – and More than Nuclear
Nuclear Two-Key Transfers
Joint Ventures and Off-Shore Production
Joint Proliferation Ventures
Off-Shore Production

The "How" – the Non-State Entities

Gift or Inheritance of a Nuclear Weapon
Independent Production

V. The "What If" of Future Proliferation

The Past State Experience
Cold War Non-Use of Nuclear Weapons
Nuclear Non-Use in South Asia – So Far, So Good?
Use of Chemical Weapons
Non-Use of Biological Weapons
One Caveat
The Presumptive State Proliferators
The Non-State Entity-State Entity Relationship
Prudential Policy-Military Planning

VI. The "Who Cares" of Future Proliferation

UN Security Council Resolution 1540 – the Wave of Things to Come?
Demoralization and Resignation – at What Point?
The Next Use of NBC Weapons
Not Whether but When, How, and by Whom
Uncertain Impacts
Danger but also Opportunity

Closing Thought

Key Projections/Forecasts

Motivations to acquire

- For future *nuclear* proliferation, status (e.g., Indian case) is increasing as a motive for States.
- Other future motives for States will resemble the past, for example enhanced political-military security, desire for regional aggrandizement, and claims of status or desires for prestige.
- The motives of non-State entities are suggested by the type of non-state entity – *Islamist Revivalists* (al-Qaeda and others wanting NBC to bolster efforts to create a new "caliphate"), *Apocalyptic Movements* (e.g., Aum Shinrikyo), *National Liberationists* (nukes to win internal wars), *Coup-Makers* (e.g., Revolt of the Generals in Algiers, nukes to enable seizure of power).

- Perceptions of nuclear weapons as the likely weapons of choice for most future proliferators could be pushed into reverse, however, by "shocks." Shocks could include examples of disastrous use (Taiwan-China-U.S. clash?), events getting out of control (India-Pakistan conflict over Kashmir), nuclear revisionism (U.S. conventional global strike options sending signal that nukes are "old hat"), and fact of non-use (strengthening perception that these weapons are not usable).
- Potential state proliferators that have a high regard for their perceived status may be disinclined to deploy CW or BW.
- Apart from Japan's use of plague in China in World War II and the controversy about mycotoxins in Southeast Asia in the early 1970s, there is no modern track record of state use of BW. The scope, nature, and consequences of a *first use of BW* could have a major shaping impact on subsequent motivations. If a nuclear response is employed against a first BW user, then the perceived utility of BW could be reduced.
- The impact of use of BW agents by a terrorist group could affect state BW proliferation calculations.

Regions/countries of greatest concern

- ***The Usual Suspects*** have been around for quite some time and are the most likely to be the next potential NBC states in the upcoming decades. These include: **Iran**, **Iraq**, and **North Korea**.
- ***Reformed Proliferators*** could revert to a proliferation track. This list includes **South Korea** and **Taiwan**, and, though less likely, **Libya** and **South Africa**.
- ***Status Seekers*** are likely to be nuclear proliferators (status does not seem to be a motivation for CW or BW proliferation). India is a recent example. Their claims to major power status have been increasingly recognized and there is a possibility that they will receive a permanent seat on the UNSC. Potential status seekers include: **Japan**, **Brazil**, **Argentina**, **South Africa**, and **South Korea**.
- ***Tough-Minded Independents*** like Sweden and Switzerland launched atomic bomb programs after World War II, but then ceased work. In the decades ahead, tough-minded independent nations such as **Singapore** and **Vietnam**, or Former Soviet Union (FSU) states like **Ukraine**, **Belarus,** and **Kazakhstan** could pursue an NBC track for security or to undergird independence.
- ***Reluctant Non-Proliferators*** who signed up to the NPT out of a sense of political necessity rather than deep conviction could drop out of the regime. Possible candidates are: **Egypt**, **Brazil**, **Indonesia**, **South Korea**, **Taiwan**, **Iraq**, and **FSU states**.
- ***Newly-Threatened Good Guys*** could reconsider nuclear abstinence. **Germany** was a former concern, but the most obvious future possibility is **Japan** facing a resurging China or a nuclearizing North Korea and fading U.S. power.
- ***New Global Powers*** could make a bid to become a nuclear power. Though seemingly unlikely today, one possibility is the **European Union (EU),** especially if Europe and the U.S. continue to drift apart.

Specific weapon types (N, B, C, R, Delivery Means), to include new or non-traditional weapons/effects/production techniques/delivery means

- In the past, proliferation most often meant *nuclear* proliferation. By late 1970s, *ballistic missile* proliferation was important, *chemical weapons* proliferation gained prominence during the 1980s, and *biological weapons* proliferation was still an undercurrent until almost the 1990s. Looking ahead, the "what" of proliferation for state proliferators could be summarized as: nuclear up, chemical down, biologicals treading water, and ballistic missiles giving way to cruise missiles and unmanned aerial vehicles (UAVs). For non-state entities, the "what" could range widely across the possibilities of nuclear, biological, or chemical weapons.
- Barring some shock or decisive turn of events, there are many reasons to believe *nuclear weapons* will continue to be the "proliferation of choice" for tomorrow's proliferators.
- *Chemical weapons* over the next decades could be viewed as useful by local leaders in clashes between third world countries (e.g., Iran-Iraq War), but could fade in appeal as a means of taking on the great powers.
- *Biological weapons* could conceivably become an increasingly prominent element of the changing face of proliferation, but questions persist regarding the ease of dissemination by regional adversaries, the effectiveness of response, the risks of escalation, and other dimensions. Nonetheless, the relative ease of producing "entry-level" BW (e.g., Tularemia, Anthrax) needs to be factored into the equation. Some countries may begin down the BW proliferation path, exploring options and possibly designing a surge capability, but then "tread water," watching and waiting to determine whether their BW would be practically useful.
- For countries contemplating BW as an asymmetric response to U.S. conventional capabilities, the relative balance of offense and defense has already begun to shift in favor of operational defense preparedness, albeit less rapidly than hoped.
- *Missile proliferation* could follow three trends in the decades ahead: (1) upgrading ballistic missile capabilities in range, accuracy, and penetration of defenses; (2) pursuit of other missile proliferation options, such as spread and refinement of cruise missiles and UAVs, and ballistic missile defenses (BMD) in a growing number of countries; and (3) the possibility that if BMD works, and spreads, it could diminish the utility and appeal of offensive ballistic missiles.

Acquisition patterns/trends

- It can be taken as a given that additional terrorist use of BW of some sort will occur (recalling Aum Shinrikyo use in the Tokyo subway and unsuccessful al-Qaeda use of Ricin in London in 2003).
- A successful high-casualty terrorist use of BW could make BW more attractive to a regional state that is seeking nuclear capability, but is still years away from the threshold, as an interim deterrent against its adversaries.

- The near-universally accepted judgment today is that it is not a matter of whether non-state entities will gain access to NBCR weapons, but when. Writ large, the judgment is probably correct. In practice, however, it is unlikely that each of the specific non-state entities will actually seek, and succeed, in acquiring access to the full spectrum of NBCR. How states proliferate has followed various pathways in the past. Therefore, looking out several decades, new pathways should be expected.
- For non-state entities, purchase or theft may be the most usual paths, but "gifts" or dedicated production are conceivable. A "gift" to a terrorist group by a state sponsor could occur if the state anticipates defeat by another power, or even if the state simply enlists a terrorist entity to help pursue a regional agenda assuming the link can be concealed and denied. "Inheritance" is also conceivable if, for example, Islamic extremists take power in Pakistan and thereby achieve control of nuclear weapons. If proliferation accelerates in the decades ahead, both "gift" and "inheritance" become more plausible. Independent production of nuclear and BW weapons is a high bar for a non-state entity, but the bar may be lowered over time.
- Dedicated national programs to develop NBC weapons and missiles will continue. Such programs are likely to be covert initially, unless a proliferation tipping point is reached when many countries might pursue nuclear weapons openly. Past experience suggests that a few key persons drive virtually all successful NBC and missile programs, and one may expect this to be true in the future.
- Most successful national proliferation programs have had help from friends. Future help could take on some "new" dimensions:
    - More A.Q. Khans – and more than nuclear: A.Q. Khan's virtual nuclear weapons for sale operation came as a surprise. Now that Khan has shown the way, it is difficult to believe other entrepreneurs will not follow suit.
    - In the BW arena, past participation in a weapons program would not be a prerequisite for entry to this business; smart and talented individuals from the bio-research and bio-technology worlds would be potential entrepreneurs.
- Technically weak countries may seek outside help on the U.S.-NATO "nuclear two-key transfer" model. Two possibilities that come to mind are Chinese supply of two-key nuclear weapons to Saudi Arabia (for guaranteed oil supplies) and Pakistani supply of nuclear weapons to Saudi Arabia (in return for funding expansion of its nuclear arsenal).
- Other acquisition patterns of future NBC and missile proliferation could be: (1) the creation of joint ventures by more than one country or (2) offshore production by one or more countries, especially after, but even short of, an explosive proliferation breakout. Offshore production of BW would be the easiest to conceal, but nuclear might be feasible. CW would be the most difficult given the logistics of production and safe transport.

Deterrence and employment concepts

- Although not used for six decades, nuclear weapons will still retain the aura of valuable instruments of deterrence.
- One lesson from the second Iraq War that is likely to carry into the future is that neither CW nor BW (both of which Iraq was believed to have) are a credible deterrent against large-scale U.S. intervention in a region of concern.
- Among non-state terrorist actors, such as al-Qaeda, the conventional wisdom is "acquisition will equal use." This may be true in some instances, but there are other possibilities. Future Islamic Revivalists that get a nuclear weapon could conceivably regard it as too valuable to detonate because it could offer a means of deterrence and coercion. Not using the weapon could legitimize and strengthen their support among Muslims at large. Using the weapon with large-scale loss of innocent life could cause the Muslim population to turn away.
- Future apocalyptic movements would be prone to use WMD – the greater the destruction and loss of life the better. While Islamic revivalists might draw the line at the release of contagious BW agents, fearing harm to the populations they seek to control, apocalyptic movements might consider such deaths a bonus.
- National Liberationist-Rebels (like the Tamil Tigers in Sri Lanka) may or may not use WMD depending on their calculation of relative strategic-tactical advantage in an ongoing conflict.
- Instead of using WMD, criminal organizations would be more likely to seek a profit by selling them, or would preserve threat of use for sub-state deterrence to gain sanctuary for other activities.
- Coup-Makers would acquire WMD to strengthen their legitimacy, confound their opponents, and support their claim to power. They would probably avoide use, except in extremity.

Areas for potential surprise

- ***Tipping Point to "Explosive" Proliferation:*** A dramatic proliferation shock or continued erosion of nonproliferation barriers coupled with a slow drift in reassessing nonproliferation postures in future decades could lead to a burst of NB or C proliferation, amplified by a bandwagon effect in which no technically capable country would want to be left behind (the "not the last and not the least" proliferation scenario).
- ***Successful use of nukes*** could be the most critical driver of widening "explosive" proliferation.
- ***Goal of nuclear use to change "status quo":*** Nuclear weapons were not used after World War II. The U.S. and eventually the Soviet Union came to believe that nuclear weapons could not be used to change the East-West status quo. The future may not closely emulate this past convention. Looking to the future, China, North Korea, Pakistan, and a future nuclear-armed Iran each may be tempted to consider use of nuclear weapons or threats of use to change an unpalatable status

quo, e.g., over Taiwan, the division of the Korean peninsula, Kashmir, or foreign military presence in the Persian Gulf.

- ***Renunciation:*** Decisions to renounce the pursuit of NBC weapons and give up related capabilities could also spread, if events move in a more positive direction for proliferation prevention – although current trends seem to obscure this possibility.
- ***Demoralization, or Stronger Regime?*** International concern about proliferation has oscillated, and could either lead to resignation that widespread proliferation is inevitable or galvanize stronger commitments and tools to head it off and contain its effects.

Specific forecasts

- The analysis above is rich in "contingent forecasts," but also posits the following straightforward forecasts:
  (1) Nuclear weapons are likely to remain the weapon of choice for proliferators;
  (2) Future proliferation will both resemble the past and adopt new pathways and forms;
  (3) Status motivations will increase in frequency;
  (4) Proliferation by or to non-state entities is likely;
  (5) Countries are likely to form WMD development joint ventures and conduct WMD development offshore; and,
  (6) The scope of proliferation could reach a tipping point and then spiral explosively, although its specific outcomes and shaping will depend in part on how the international community responds, particularly to the next first use of nuclear weapons or first use of BW.
- The paper also forecasts that missile proliferation trends will continue in the areas of accuracy and range, thus augmenting ballistic and cruise missile delivery capabilities for nuclear weapons and other WMD, which will probably hasten development of missile defenses.

Significant Points

- The shape of future proliferation will depend not only on current state and non-state entity motivations for WMD acquisition and the technical diffusion that accompanies globalization, but also on how the international community responds to proliferation events, particularly the next big shock or shocks.
- It is unclear how the international community will react to the next use of nuclear (or biological or chemical) weapons.
- Many nations will not believe that nonproliferation is practically attainable if the tipping point is reached.

- The successful use of NBC weapons would be a powerful proliferation multiplier. But, conversely, the next use of NBC weapons could galvanize international action against proliferation.
- Past experience shows that the most critical U.S. and global actions to strengthen nonproliferation have followed proliferation shocks.
- UNSC Resolution 1540 can be a template and building block for rallying nations to act against state and non-state entity proliferation. This is both significant to note and should not be underestimated.

Other Major Conclusions and Unique Dimensions

The author's thought process and presentation offers a uniquely complex portrait of the possible forms and permutations of future WMD proliferation among states and non-state entities and the variety of motives that could determine whether, when, and how NBC weapons obtained through future proliferation are actually used. The author is sure-footed in tracing the potential calculations or scenarios of regarding nuclear, biological, and chemical weapons acquisition and use throughout his analysis of numerous characteristic types of proliferators.

Conclusions

The paper descriptively analyzes many facets of the changing face of proliferation, at state and non-state levels, but emphasizes that the future of proliferation is not a given. The policies pursued (and not pursued) by the U.S. and like-minded countries can significantly impact the scope, shape, characteristics, and timing of NBC proliferation. The dire predictions about runaway nuclear proliferation of the 1950s and early 1960s did not materialize as self-fulfilling prophecies because international actions intervened to make them self-denying prophecies. Intensified actions today along many fronts could have a similar impact.

The Lugar Survey on Proliferation Threats and Responses

Richard G. Lugar
Washington, D.C.: U.S. Senate, 2005

Purpose and Objectives
To collect and identify consistencies and divergences in views on the prospects for nonproliferation through a poll of selected experts on proliferation and national security. In illustrating consistencies and divergences, the author's hope is that the results will be useful in defining the risk parameters of proliferation as well as in identifying public policy issues that need more attention.

Timeframe Examined
2010-2015 (between five and ten years)

Prevailing Context
The rising post-9/11 concerns about WMD proliferation threats, in particular, the possible terrorist group acquisition or use of a WMD in the U.S. homeland.

Methodology
The survey analyzes the responses of eighty-five experts to a questionnaire. Experts ranged from scholars, policy makers, diplomats, and technicians known for their experience with national security and nonproliferation policies. The majority of the respondents were from the U.S., but a few were from overseas. Survey participants were instructed that they could leave questions blank if they felt that they did not have the expertise to provide an answer.

Report Format
The study has two parts: assessing proliferation threats and international nonproliferation responses. In part one, the study surveys how many nations are expected to proliferate nuclear weapons, the risk of a CBRN attack, and the most likely method of terrorist acquisition of a WMD. Part two of the study surveys respondents' views in the following categories: status of international nonproliferation efforts; government spending on nonproliferation; recommended spending increases; encouragement of developments in nonproliferatation capabilities; nonproliferation priorities; and underrated proliferation risks.

Key Projections/Forecasts
Part I

a. Nations that will be added to nuclear club:
    i. In next 5 Years: 90% agreed between 1 and 3
    ii. In next 10 Years: 78% agreed between 2 and 5
    iii. In next 20 Years: 75% agreed between 4 and 10
b. Risk of Nuclear Attack (somewhere?)

i. 5 Years: 60% of respondents judged the probability to be at least 10%.
ii. 10 Years: 20% probability

c. Nuclear attack: by a government or by terrorists?
   i. 79% said that if a nuclear attack occurs in the next 10 years, then it is more likely to be carried out by a terrorist organization.
d. Most likely method of terrorist acquisition
   i. 75% of respondents judged the black market to be the most likely means of acquisition.
e. Risk of biological attack:
   i. 5 Years: 10 - 20% likelihood
   ii. 10 Years: at least 20% likelihood
f. Risk of chemical attack:
   i. 5 Years: 10 - 30% likelihood
   ii. 10 Years: 15% likelihood
g. Risk of radiological attack:
   i. 5 Years: 25% likelihood
   ii. 10 Years: 40% likelihood

Part II

a. Status of nonproliferation efforts
   i. 46% of respondents believed international nonproliferation efforts have regressed during 2004.
b. Government spending on nonproliferation
   i. 78% of respondents indicated that their country was spending too little.
c. Recommended spending
   i. 70% of respondents stated that their country should spend at least 25% more on nonproliferation programs.
d. Encouraging developments in nonproliferation capabilities
   i. 27 respondents noted the PSI as the most important
   ii. 23 respondents noted UNSCR 1540 as the most important
   iii. 20 respondents cited CTR as the most important
   iv. 14 respondents cited GTRI
   v. 12 respondents cited the reaffirmation of the G8 Global Partnership
e. Nonproliferation priorities
   i. 27 respondents noted dismantling, securing, and destroying CBRN weapons in the former Soviet Union.
   ii. 14 respondents noted ending the North Korean nuclear program
   iii. 9 respondents noted global control of fissile material
   iv. 8 respondents noted strengthening NPT

f. Underrated proliferation risks
    i. The risk that requires the most attention is the possiblility of terrorists acquiring WMD

Conclusions
None provided.

Special Issue: Nuclear Weapons Proliferation: 2016

The Nonproliferation Review 13, no. 3 (2006): 617-25

Note
Guest Editor, Peter R. Lavoy. This symposium volume consists of seventeen articles, one by the guest editor, and fifteen individually authored pieces, and one co-authored piece (see "Report Format section below for table of contents):

Commissioned By
The "Nuclear Weapons Proliferation: 2016" conference organizers at the Center for Contemporary Conflict, Naval Post-Graduate School, Monterey, California in July 2006.

Purpose and Objectives
To forecast nuclear proliferation conditions ten years out. The outline of questions originally used to organize the conference is not spelled out in the journal. However, the editor of the journal, Stephen Schwartz, states in his preface to this special issue that the collected essays "examine the issues most likely to influence nuclear proliferation over the next decade," and all the authors "address to some extent three underlying questions: (1) What drives and enables a country to pursue nuclear weapons? (2) What early warning signs can be observed in countries seeking nuclear weapons? And (3) What steps can be taken to halt or impede proliferation during the next decade to keep instability and threats to the [nonproliferation] regime at a minimum?"

Timeframe Examined
2006-2016.

Prevailing Context
The prevailing context for commissioning the individual papers was not spelled out explicitly. Internal evidence suggests that the most important international events which provided background to those essays that contain some form of forecasts were: (1) disclosures of Iran's progress in developing and installing gas-centrifuge uranium enrichment technology; (2) reports that North Korea had successfully sequestered a stockpile of weapons-grade plutonium and could test a nuclear device in the near future (North Korea actually detonated a plutonium nuclear device on October 9, 2006, just before the journal issue was published but well after papers had been assigned and the July, 2006 conference was held); and, in reaction to these developments, (3) news reports suggesting there could be further nuclear proliferation in East Asia and the Middle East. Other developments that affected the perspective of individual authors were the Libyan about-face on WMD and missile programs in 2003; reports in 2002-2003 of a non-state actor's (i.e., al-Qaeda's) efforts to purchase and to develop and produce WMD; and, the disclosures of the A.Q. Khan network and its activities in early 2004.

Methodology
The articles are all qualitative analyses, either historical (with lessons) or thought pieces about the future based on a combination of past research and expertise in the field of nuclear proliferation and on various regions of the world. The uniqueness is not in methodology as such, but in the conference approach of drawing a panel of experts together to attempt to identify "what issues [are] most likely to influence nuclear proliferation over the next decade." The focus of the symposium is primarily on nation-state proliferation, and secondarily on "transnational proliferation networks." The one essay dedicated to non-state actor proliferation deals not with the demand side (e.g., terrorist acquisition of WMD) but rather with the supply side, i.e., the prospective emergence and operation, beyond the reach of the nonproliferation regime, of networked non-state entities whose business is to supply and service products of proliferation importance to buyers, whether states or non-state entities, possibly including, among the latter, criminals, warlords, or terrorists.

Report Format
The table of contents of the journal's special issue on "Nuclear Weapons Proliferation: 2016" is reproduced below. Not all of the essays provide future nuclear weapons proliferation "forecasts;" pieces that have been assessed in this document have an asterisk in front of a title.

I. Introduction
*****_Nuclear Proliferation over the Next Decade: Causes, Warning Signs, and Policy Responses_, Peter R. Lavoy.

II. Insights from the Past: Theory, Intelligence, and Policy
Theories of Nuclear Proliferation: The State of the Field, Jacques E. C. Hymans.
Anticipating Nuclear Proliferation: Insights from the Past, Torrey C. Froscher.
*****_Countering Proliferation: Insights from Past "Winds, Losses, and Draws,"_ Lewis A. Dunn.

*_Identifying Nuclear Aspirants and Their Pathways to the Bomb_, Robert J. Einhorn.

III. Past Cases of Nuclear Proliferation and Nuclear Reversal

Nuclear Proliferation Motivations: Lessons from Pakistan, Feroz Hassan Khan.
South Africa's Nuclear Weapons Policies, Stephen F. Burgess.
Lessons Learned from Iran's Pursuit of Nuclear Weapons, Mark Fitzpatrick.
*Nuclear U-Turns: Learning from South Korean and Taiwanese Rollback, Rebecca K. C. Hersman and Robert Peters.
Egypt's Nuclear Weapons Program: Lessons Learned, Maria Rost Rublee.

IV. Future Nuclear Proliferation Risks

*****_Nuclear Proliferation in Europe: Could It Still Happen?_ Bruno Tertrais.

*****_The Future of Nuclear Weapons in the Middle East_, Abbas Kadhim.
*****_Future Nuclear Proliferation Scenarios in Northeast Asia_, James Clay Moltz.
*****_Prospects for Nuclear Proliferation in Southeast Asia, 2006-2016_, Michael S. Malley.
*****_Assessing Potential Nuclear Proliferation Networks in Latin America: 2006-2016_, Harold A. Trinkunas.

V. New Dynamics in the Proliferation Environment

*****_The Nuclear Energy Market and the Nonproliferation Regime_, Chaim Braun.
*****_Peering into the Abyss: Non-State Actors and the 2016 Proliferation Environment_, James A. Russell.

Key Projections/Forecasts

Motivations to acquire

- Once critical U.S. security guarantees are no longer a nonproliferation "free good". Looking ahead, the scope and pace of future nuclear proliferation will continue to be closely intertwined with the robustness and credibility of U.S. security alliances in meeting (or failing) the real and perceived security needs of critical countries. (Dunn)
- Whatever its format, the U.S. nuclear umbrella over Europe probably remains the most important factor for dissuading motivations for further nuclear proliferation on the continent.
- Security shocks (e.g., nuclear weapons in North Korea or Iran) that impact the security and influence the calculations of neighbors could open up new nuclear weapon motivations in their regions. (Various authors)
- A combination of two factors could make Turkey think seriously about going nuclear. The first is the advancement of Iran's nuclear program and the second is a sense of alienation vis-à-vis the rest of the Western community. (Tertrais)
- Several Middle East states exhibit a felt need to acquire WMD to counterbalance Israel's nuclear arsenal and conventional military superiority. (Kadhim)
- Iran's current and projected motivations for nuclear and missile capabilities are to protect against U.S. pressures for regime change; potential U.S. and Israeli preemptive conventional military attack; and perceived nuclear-backed threats from the U.S., Israel, and Pakistan. (Khadim)
- Iran's rise as a nuclear power is likely to give Saudi Arabia the incentive to build a nuclear program, but it lacks the scientific base and would find it difficult to keep it covert given the U.S. military presence there as well as in Kuwait and Qatar. Consequently, it is unlikely that Saudi Arabia will have a nuclear program in the coming decade (2006-2015). (Khadim)
- Iran's rise as a nuclear power could also precipitate a revived nuclear program in Egypt, which has the requisite scientific base but would face serious constraints in moving forward successfully due to scarce financial resources. (Khadim)

Regions/countries of greatest concern

- The symposium considers the regions of greatest nuclear proliferation concern to be the Middle East and Northeast Asia, but also includes second or third order concerns about the future of potential proliferation in Europe, Latin America, Africa, South Asia, and Southeast Asia.
- Countries of greatest concern on the demand side, either because of their interest in the past or possible interest in the future, include: Ukraine, Serbia, Turkey, Syria, Iran, Libya, Algeria, Egypt, Saudi Arabia, South Africa, Pakistan, India, Burma, Indonesia, North Korea, South Korea, Taiwan, Japan, Brazil, Argentina, and Venezuela. (Various authors.)
- Proliferation indicators and warning signs that will continue to be useful in detecting and characterizing nuclear proliferation are: (1) nuclear myths and myth-makers (e.g., public statements and activities intended to create support for nuclear weapons programs); (2) travel of nuclear managers or technicians to interact or procure; (3) promotion of known or presumed nuclear weapons advocates to higher positions; (4) acute, adverse changes in a state's security circumstances – as perceived by that state's leaders and strategists; (5) indicators in nuclear program activities (e.g., sending people abroad for training, procurement efforts in sensitive items, involvement of military and intelligence officials in ostensibly civilian nuclear research and development programs, and technical cooperation or trade with key countries or with entrepreneurs in key technical areas); and (6) evidence of covert dealings in the market or covert cooperation with suspicious partners. (Lavoy)
- Adverse developments and trends have increased the likelihood that we are headed toward a more widely proliferated world. These events and trends include the impact on neighbors of nuclear weapons programs in North Korea and Iran, China's military buildup; U.S. preoccupation with Iraq and strains with allies; diffusion of nuclear and dual-use technology; the A.Q. Khan black market phenomenon; acquisition of concealable technologies; and U.S. and NSG members' willingness to engage in nuclear cooperation with India, thus lowering the perceived costs of going nuclear. (Einhorn)
- Countervailing developments and trends, such as increased international scrutiny, strengthened nonproliferation tools (including UNSC Resolution 1540 and the Proliferation Security Initiative), and the still-limited technical and industrial base of many potential proliferators could also slow nuclear proliferation. (Einhorn)
- Middle East: See below under "Specific Forecasts".
- Currently, Southeast Asia has almost no interstate or extra-regional security threats that would be an incentive for nuclear weapons programs. Addtionally, the region has evolved associational agreements, political cooperation, and norms that make nuclear proliferation very unlikely, at least during the next ten years. Burma (Myanmar) is a possible exception to the regional trend in its military rule, general isolation, and military ties with North Korea. Even so, Burma probably does not have the resources to develop a serious nuclear weapons program in the coming decade. Indonesia has the largest national concentration of civil nuclear expertise

and infrastructure in the region and newly invigorated interest in building nuclear plants for electricity-generation, but no apparent interest in nuclear weapons. The primary proliferation concern for Indonesia is the possible participation of its public or private firms in multinational nuclear trading networks with Iran, other proliferator states, or illicit nuclear and dual-use supplier firms. (Malley)

- Over the next 10 years, Northeast Asia could become one of the most volatile regions of the world with respect to nuclear weapons. It contains two established nuclear weapon states – Russia and China, a third with presumed nuclear weapons – North Korea, and three threshold nuclear states – Japan, South Korea, and Taiwan. One cannot escape the conclusion that Northeast Asia is a nuclear tinderbox that could easily ignite. (Moltz)
- In Latin America, nuclear weapons proliferation trends of the 1960s and 1970s (primarily in Argentina and Brazil) have largely been reversed by democratization, confidence in national sovereignty, economic advances, and international legal instruments with monitoring institutions such as the Treaty of Tlatelolco and the Argentine-Brazil bilateral nuclear inspection agency (ABACC). The main proliferation risks from Brazil and Argentina over the next ten years would be from their inclination to be alternative suppliers of nuclear technology and potential to be caught up in multinational nuclear networking with critical nations and illicit end users. Otherwise, the main state of concern is Venezuela under Chavez, who envisages a domestic nuclear energy program, has spoken out against nonproliferation norms, and attempted to cultivate nuclear import relationships with Argentina and Brazil and possibly with Iran and North Korea. Venezuela today has virtually no nuclear scientific base, infrastructure, or interest groups to support a nuclear research and energy program. Notwithstanding revenues from oil and the possible import of turnkey technology, it is highly unlikely that Venezuela's nuclear program could be developed sufficiently in the next decade to pose the direct risk of nuclear weapons production. (Note: Cuba is not discussed as a significant nuclear proliferation risk in this article on Latin America.) (Trinkunas)

Specific weapon types (N, B, C, R, Delivery Means), to include new or non-traditional weapons/effects/production techniques/delivery means

This symposium focused on nuclear weapons proliferation and has no specific analyses of CW, BW, or radiological threats, and virtually no content or analysis of delivery systems.

Acquisition patterns/trends

- Acquisition patterns by determined proliferators will "innovate," even as nonproliferation regime controls tighten. (Dunn)
- Despite military modernization programs, China has maintained relative restraint in the size of its nuclear arsenal which is generally estimated to be about 400 weapons (some recent analysis that suggests it may be only between 80 and 130 deployed

nuclear weapons). China has substantial fissile material stockpiles, however, that would allow production of upwards of 1,000 nuclear weapons. (Moltz)

- Burma has military cooperation with North Korea that evidently includes nuclear technology content and possible transfers. (Malley)
- Iran has been seeking to cultivate ties with Indonesia including cooperation in nuclear technology. While Indonesia itself shows no interest in nuclear weapons, its growing technical ties with Iran to foster serious nuclear energy plans to meet Indonesian energy requirements could lead Indonesia to become, inadvertently, a part of wider regional and global proliferation networks. (Note: the author has no estimates or analysis of nuclear proliferation conditions or potential in Vietnam.) (Malley)
- Non-state and quasi-government organizations doing business in transnational networks, essentially offshore, may become very important on the supply side of nuclear proliferation by 2016, by producing, selling, and servicing products of proliferation importance to government agencies as well as to other non-state entities best characterized as criminals, warlords, or terrorists. (Russell)

Deterrence and employment concepts

This symposium focused primarily on prospective nuclear acquisition and infrastructure and did not address the military doctrines or uses of nuclear weapons. Basic deterrence is considered a generic motive for nuclear weapons programs and acquisition, but generally the authors do not explore or analyze nuclear deterrence or nuclear weapons employment issues.

Areas for potential surprise

- Proliferation shocks that could impact and shape the state of future proliferation, such as: a successful or aborted use of nuclear weapons by terrorists; a nuclear weapon accident in India or Pakistan; a confirmed theft of nuclear materials or weapon; an escalation to nuclear use between India or Pakistan; an NPT breakout by Iran; Pakistani or Chinese deployment of nuclear weapons to Saudi Arabia under a 'NATO-like' dual-key arrangement; a U.S.-China-Taiwan crisis with threats or actual use of nuclear weapons; or open Israeli deployment of nuclear weapons. (Dunn)
- Fears of runaway proliferation have energized the U.S. and other governments to act together to make those fears a self-denying prophecy; leveraging future nuclear surprises in favor of nonproliferation has worked in the past and could work this way again. (Dunn)
- The attention currently focused on North Korea and Iran is imperative, but it is also problematic. Keeping the spotlight focused on Iran and North Korea … risks keeping too much of the rest of the nuclear landscape in the shadows and opening ourselves to dangerous surprise. (Hersman and Peters)
- Countries that formerly pursued nuclear weapon programs but were "rolled back" by pressures and incentives could resume such programs. "The record of rollback in [South Korea and Taiwan] emphasizes the fact that nuclear rollback is a process,

not an outcome or state of being – success in the past by no means assures success in the future. Rollback in South Korea and Taiwan is not 'over' – intent could change rapidly with little warning, sending these countries back into the 'danger zone.' … Failure to maintain attention might invite an era in which the long-feared scenario of 'nuclear dominoes' – when one state's decision to reconsider the role of nuclear weapons in its national security calculus sets off a cascade of such decisions in other states – comes to pass." (Hersman and Peters)

Specific forecasts

- Nuclear Turkey possible: timeframe 2010-2025, probability under 10%, under conditions of continued degradation of U.S.-Turkish relations, Iranian nuclear capability, non-entry in the EU, withdrawal of U.S. nuclear weapons from Europe, Russian assertiveness in the Caucasus and Central Asia, and NPT breakdown. (Tertrais)
- Nuclear Ukraine hypothetical: timeframe 2015-2025, probability under 5%, under conditions of non-entry in NATO and EU, proximity to and continued tensions with Russia, and NPT breakdown. (Tertrais)
- Nuclear Serbia hypothetical: timeframe 2015-2025, probability under 5%, under conditions of non-entry in NATO and the EU, exacerbated Serbian nationalism, and NPT breakdown. (Tertrais)
- New EU nuclear state wildly speculative: timeframe 2015-2025, probability under 1%, only under conditions of complete breakdown or severe crisis of existing security arrangements in Europe (NATO, EU) and emergence of serious regional threats. EU countries not already mentioned that come to mind under various scenarios: Finland, Sweden, Italy, Spain, Poland, Greece, and Germany. (Tertrais)
- In Northeast Asia, following a decision to develop nuclear weapons, the timeframes for the three threshold states to fabricate a bomb would be as little as 1 year for Japan, 1-2 years for South Korea, and 2-3 years for Taiwan. (Moltz)
- Burma's increasing isolation and suspicion, growing access to North Korean nuclear technology, and increasing financial resources from natural gas discoveries make it plausible that Burmese leaders may seek to acquire nuclear explosive devices during the coming decade. However, its capacity to develop and manufacture such weapons is so limited today that it is difficult to imagine how, within a decade, Burma could do more than rely on outsiders to construct, supply, and maintain a limited nuclear weapons capability. (Malley)
- The global nuclear energy system of 2016 will probably bring a 10% increase in installed nuclear power plant (NPP) capacity (an evolutionary increase) and thus will not be qualitatively much different than the system of 2006. With the implementation of currently proposed enhancements, the nonproliferation regime of 2016 should contain the expected proliferation risks related to sustain nuclear energy growth. There are, however, many qualifications and caveats to the above statements touched on by the author. In the following decade to 2026 qualitative

changes (e.g., spread of FRs or "fast reactors") and related challenges are likely. (Braun)

Significant Points

- **Indicators of nuclear weapons decisions** that may be detected: (1) declaratory policy in writings and statements, from carefully reading original-source documents in the native language; (2) decisions to remain in NPT, withdraw, or complicate inspections; (3) unusual construction activity; (4) explosives tests that may be bomb related; (5) suspicious purchases; (6) delivery vehicle tests; and (7) the relocation and cessation of open publication by top scientists. (Moltz)
- **Detecting and interpreting proliferation effects of trigger events** such as: (1) DPRK nuclear test (the article was completed before the DPRK's nuclear test on October 9, 2006); (2) collapse of the NPT; (3) major Chinese nuclear expansion; (4) ultra-nationalist Korean reunification; (5) sudden U.S. withdrawal from the region; and (6) nationalist Russian nuclear rearmament. These six possible trigger events are particularly important in Northeast Asia. (Moltz)
- **Nuclear rollback** is a process, not an outcome or state of being. (Hersman and Peters)

Other Major Conclusions and Unique Dimensions

- Taken together, the journal articles amount to a serious effort to identify future proliferation conditions and outcomes around the world, anticipate indicators of new proliferation, and foresee triggering events, with special attention to key countries of concern and each region of concern.
- This symposium is one of the first to take transnational nuclear supply networks into account as a major supply side variable in proliferation forecasts. (Dunn and Russell)
- The collection of analyses is also one of the first to attempt to assess how the projected expansion of the global nuclear power industry over the next decade may affect the scope and rate of nuclear proliferation. (Braun)
- Europe is nearly immune to further horizontal nuclear proliferation, according to conventional wisdom. While the chapter on Europe agrees that there is a very low probability over the next two decades for further nuclear proliferation, it speculates on conditions under which it could occur, especially if there is a cascade of new proliferation elsewhere.

Conclusions

The symposium as a whole forecasts that nuclear proliferation is slow and may be contained, but acknowledges that proliferation triggering events in Northeast Asia or the Middle East could bring the state of proliferation to a tipping point, when barriers are breached and a cascade of new nuclear proliferation occurs.

Several of the articles deal with states that formerly had nuclear weapons programs and have dropped them, but also discuss the conditions under which a number of these states could resume that path, often from a more established base in nuclear and, in some cases, missile technology.

Thwarting an "Evil Genius": Summary of Workshop Proceedings

Gregory F. Giles, Eleanore Douglas, Todd Koca, and Tom Skypek
In Thwarting an Evil Genius Workshop
Washington, D.C., SAIC and DTRA, 2006

Commissioned By
Defense Threat Reduction Agency, Advanced Systems and Concepts Office.

Purpose and Objectives
To postulate how intelligent and innovative enemies might attack the American homeland in the near future.

On June 28-29, 2006, the U.S. Defense Threat Reduction Agency (DTRA) convened a group of the nation's most creative thinkers to address this topic, drawn from the realms of literature, entertainment, academia, public health, science, and technology. The stated working assumption was that creative, intelligent, and innovative adversaries exist and are seeking ways to attack the U.S. with the desire to achieve effects that would alter individual and collective decision-making, as well as having the potential to fundamentally change our societal interactions. The objective for the group was to use their creative thinking to imagine what kinds of attacks such adversaries could devise. What would "evil geniuses" do to exploit vulnerabilities and harm the U.S?

Timeframe Examined
2006-2011

Prevailing Context
Critical security risks in U.S. homeland security made evident by the 9/11 attacks.

Methodology
In considering more novel approaches to how an intelligent and determined adversary may attack U.S. homeland, DTRA assembled a group of the nation's most creative thinkers from the psychology, sociology, law, information technology, fiction, design innovation, and terrorism fields. The groups were given only two restrictive parameters to follow when developing scenarios: that the attack must occur within the next five years and that the adversary must use existing technology.

Report Format
I. Today's conventional wisdom: a review of the compendium of existing homeland attack scenarios as well as the participants' reaction to the baseline scenarios.
II. Participant's ideas, schemes, and "unthinkables."
III. Working group presentations and discussion of "Evil Genius" scenarios.

IV. Workshop results and implications for DTRA.

Key Projections/Forecasts

The study's focus was not on any one particular WMD or method of attack. Additionally, working group participants did not focus on a single perpetrator, but rather posited that the next attack could come from a lone terrorist or from a state-sponsored terrorist group.

The motivation for a person or group to attack the U.S. was generalized in the term "evil." Evil was used to describe the ultimate intent of the actor, i.e., to achieve effects that result in sudden, dramatic changes to the U.S. and the U.S. way of life.

Specific forecasts

Workshop participants were also asked to develop scenarios that reflected the notion of an "evil genius" and ways in which such an enemy might seek to exploit existing or unidentified vulnerabilities in American society. Participants rank-ordered these scenarios as posing the greatest risk to the U.S. homeland:

1. The "Kiddie Bomb" – a foreign or home-grown terrorist recruits small cells of like-minded individuals to launch a sustained campaign of school bus bombings. The campaign adapts/escalates to include other target classes such as churches, sporting events, etc., to undermine public confidence in government.
2. "Synthesized, Resistant, Hard to Detect Smallpox" – a malevolent individual bent on mass killing develops and releases a new strain of smallpox.
3. "Dual Campaign of Dirty Bombs and Nuclear Threats" – a group of terrorists, possibly with state support, launches a campaign of attacks across the U.S. involving the detonation of radiological dispersal devices (RDDs). The attacks are designed to inflict economic damage on America and to exploit the public's fear of radiation. To exacerbate that anxiety, the terrorists leave behind traces of highly-enriched uranium and claim to have a fission bomb, as well. The group relies on American media to whip up public hysteria of imminent nuclear attack.
4. "Attacks with Dual Bio Agents against Mega-Malls" – an anti-globalist loner recruits unwitting accomplices to infect 3-4 U.S. shopping malls with two different types of biological agents. The attacks are designed to damage the American economy during the critical holiday shopping period. The use of dual bio agents delays prompt identification and treatment of the infected.
5. "The Perception Bomb" – an internal or external group infects a small number of migrant workers in the U.S. and Mexico with a contagious viral disease to fuel public demand for border closure. The attack is intended to create economic disruption and exacerbate societal tensions.
6. "Serial Arson Campaign" – a loner conducts an on-going campaign to set buildings, whole neighborhoods, and the countryside ablaze in an effort to inflict casualties, property loss, indirect economic costs, and otherwise disrupt society.
7. "Civil Aviation—Nuke—Iran" – an Islamist group bent on widening U.S. military operations against the Muslim world uses corporate jets rigged with

shaped charges to damage or destroy 2-3 U.S. nuclear power reactors. The operation is conducted under a "false flag" to implicate Tehran, thereby provoking U.S. military "retaliation" against Iran.

8. "The Katrina Bomb" – a hostile element launches an opportunistic attack against a region stricken by a natural disaster to amplify the consequences.
9. "Variegated Kaczynski" – an exceptionally bright domestic terrorist launches a campaign of attacks against schoolchildren and infrastructure targets using such low-tech means as a sniper rifle, incendiary devices, and bombs. Because he operates alone, this terrorist is extremely difficult to detect beforehand and to pursue even after his campaign becomes clear.

Significant Points

The working group participants identified the following "white space" in the current threat assessments and homeland security preparations:

- While much of current planning is focused on al-Qaeda and like-minded foreign extremist groups, technology diffusion increasingly enables lone actors from ordinary American society to inflict harm on a scale that could fundamentally alter the American way of life.
- Whereas current U.S. homeland security planning is focused on an isolated event, or a small number of attacks occurring nearly simultaneously, we are not prepared to address terrorist campaigns, that is, multiple attacks sustained over an extended period. Among other effects, a campaign of attacks could have a deeper impact on the American psyche, causing people to lose more faith in government the longer the attacks continue.
- Similarly, current efforts tend to focus on dealing with the direct effects of a given attack (e.g., casualties, property damage), yet sophisticated terrorist attacks may be centered on achieving second- and third-order effects, such as prompting the government to react in ways that serve the terrorists' goals (e.g., triggering retaliation, curtailing civil liberties).
- Although much of our attention has been focused on protecting infrastructure, continuity of government, and business operations, the safety and security of schoolchildren is also a critical vulnerability. Attacks on this segment of the population could have profound national effects. For example, as fear gripped parents, they would be forced to stay home from work to protect their children, causing major workforce, economic, and societal disruptions.

Other Major Conclusions and Unique Dimensions

One unique dimension to the study was in the way "genius" was defined. The working group suggested five ways in which "genius" could manifest itself in threats to homeland security: operational innovation; technological savvy; infrastructure expertise; manipulation of passions; and gaining access.

- Genius as Operational Innovation. Genius could entail operational innovation in effect, an ability to find an unexpected and previously unknown way to attack a given target or carry out an overall attack. Operational innovation could also involve carrying out a given attack with far fewer resources, less visibility, and generally in a way that would lessen the risk of detection or defeat.
- Genius as Technological Innovation. Genius could involve technological innovation, such as coming up with a new means of attack. In that regard, one of the tasks of the participants was to identify such technical innovations. Perhaps with the exception of an attack entailing two different biological agents with different incubation times, few technically innovative means were identified; instead participants tended to focus on the other three dimensions of evil "genius."
- Genius as Infrastructure Expertise. Some of the attacks considered in the workshop required neither operational innovation nor technological innovation. Instead, the genius was the understanding of vulnerabilities in the U.S. critical infrastructure, so that a relatively simple attack might have very large-scale consequences.
- Genius as Manipulation of Passions. The goal of an evil genius adversary may be to provoke the American public and even more, America's governing institutions at all levels to "over-react" to an attack (e.g., via conflict-widening retaliation, curtailment of civil liberties).
- Genius in Gaining Access. A knowledgeable "insider" could have both the expertise and the access needed to conduct a high-impact attack on the U.S. homeland; thus, the genius of an evil person might be to patiently position himself in a job where he can do catastrophic damage.

Conclusions

The conclusions confirmed that attacks against school children, the sophisticated use of biological agents, and a campaign involving RDD's were the participants' top concerns as the types of threats posing the "Greatest Risk to U.S. Homeland".

Scen. Rank	Greatest Risk to U.S. Homeland	Hardest to Thwart
1	The Kiddie Bomb	Variegated Kaczynski
2	Smallpox	The Kiddie Bomb
3	RDD/Threat Campaign	RDD/Threat Campaign
4	Dual Bio	The Perception Bomb
5	The Perception Bomb	The Katrina Bomb
6	Serial Arson Campaign	Smallpox
7	Civil Air—Nuke—Iran	Dual Bio
8	The Katrina Bomb	Serial Arson Campaign
9	Variegated Kaczynski	Civil Air—Nuke—Iran

The study highlighted the following implications for DTRA in terms of WMD detection, modeling, and consequence management:

- A terrorist campaign involving multiple RDD attacks and nuclear weapon threats underscores the excessive and sustained demands that a future attack could place on DTRA nuclear detection, modeling, and consequence management capabilities. A systematic, structured assessment of these demands based on the RDD/Nuclear Threat Campaign scenario could be undertaken to determine if current capabilities are sufficient or if remedial action, including new investment, is needed.
- Similarly, the workshop highlighted the threat posed by synthesized, resistant, and hard to detect strains of smallpox. It also called attention to the use of dual biological warfare agents to mask effects and delay detection. DTRA's activities with respect to bio detection could be re-examined to determine how they might contribute more effectively to countering these threats.
- On a related note, previous work by DTRA to compile the various federal, state, and local statutes and authorities that would govern DoD involvement in domestic consequence management could be revisited in light of the evil genius scenarios to determine if the existing authorities remain adequate or if new ones should be sought.

Determinants of Nuclear Weapons Proliferation

Dong-Joon Jo and Erik Gartzke
The Journal of Conflict Resolution 51, no. 1 (2006): 167

Commissioned By
Independent academic study by Dong-Joon Jo of the University of Seoul, Korea and Erik Gartzke of Columbia University.

Purpose and Objectives
To increase overall understanding and cumulative knowledge of nuclear proliferation trends and outcomes by applying statistical analysis. Noting that few attempts have been made at applying quantitative concepts to predict or forecast nuclear proliferation decisions and outcomes, the authors view multivariate regression analysis essential to diversifying the theoretical claims and "contingent nature" of nuclear proliferation.

Timeframe Examined
1939-1992

Prevailing Context
Not conducted in response to any particular national or international event. However, the authors did conduct the study in the wake of the North Korean nuclear tests.

Methodology
The authors bin time series and country data gathered on a series of narrower variables into nuclear determinants in two categories: opportunity and willingness. Nuclear opportunity refers to environmental constraints as well as a country's physical capacity to build a nuclear weapon. Willingness describes a country's desire to possess nuclear weapons. According to the authors, willingness includes both domestic and geopolitical conditions that could influence a country's decision to pursue nuclear weapons.

A standard cross-sectional time series dataset is used for the period 1939 to 1992. A probit regression analysis is used to estimate the effect of variables on the presence of a nuclear weapons program as well as a censored probit analysis of nuclear weapons conditional on a given state having a nuclear weapons program (weapons possession contingent on program status). (Editorial Note: The probit coefficients measure the effect of a unit change in the independent variable on the likelihood of Y=1 in terms of z-score.) The combination of nuclear weapons program status and nuclear weapons possession yields three outcomes: (1) states that lack both a program and weapons; (2) states with programs but no weapons; (3) states with both a nuclear weapons programs and nuclear weapons.

Report Format

Conceptual Framework

- *Opportunity*: The opportunity concept is permissive and assumes a state's nuclear proliferation acts will, if they occur, depend on existing national capabilities. The concept as used is organized into three categories: (1) the set of technologies and knowledge the state has in relation to nuclear weapons production; (2) the state's access to fissile material; and (3) the state's economic capacity.
- *Willingness*: In contrast to opportunity as a permissive concept based on capabilities, the willingness concept contains drivers. Under willingness, the motivations to acquire nuclear weapon capabilities can be divided into four categories: (1) to acquire based on insecurity, as when a state finds that an adversary possesses nuclear weapons and pursues its own nuclear weapons to offset the adversary's threat; (2) to divert attention from domestic issues or because of domestic/ internal pressures; (3) to proliferate or not proliferate in order to adjust their behavior in accordance with international expectations; and (4) to enhance its international status.

Research Design

- Dependent variables
  - *NWEAPON*: Whether a state possess a nuclear weapon in a given year provided that state has an active nuclear weapons program.
  - *NPROGRAM*: Whether a state has an active nuclear weapons program within a given year.
- Explanatory variables
  - Opportunity variables
    - *Latent nuclear weapons capacity*
    - *Economic capacity*
    - *Diffusion*
  - Willingness variables
    - International security
      - *Conventional threat*: Based on the Composite Index of National Capabilities (CINC).
      - *Nuclear threat (binary)*
      - *Nuclear defense pact (binary)*
      - *Diplomatic isolation:* Ratio of the number of states with which a given state lacks diplomatic relationships to the number of neighboring states and major powers.
    - Domestic Politics
      - *Domestic unrest:* Weighted number of reported domestic conflicts.
      - *Democracy:* Uses the Polity IV democracy score.
      - *NPT membership (binary)*

  - *NPT (system effect):* Measure between the number of NPT signatories and the total number of states.
- Status
  - *Major power status:* Uses the standard COW classification.
  - *Regional power status*: Measure based on a state's resources compared to the resources of the largest state in a region.

Results and Implications

Key Projections/Forecasts

Motivations to acquire

- The results of the statistical analysis indicate that the majority of the opportunity variables behave as the authors hypothesized. That is, diffusion increases the probability of a state developing a nuclear weapons program and raises the risk of nuclear weapons proliferation. Also, the authors determined that economic capacity is a critical factor in "deepening nuclear proliferation" while an already established latent nuclear weapons production capability is more useful in determining whether or not a state will initiate a nuclear weapons program.
- The authors report that diplomatic isolation is not by itself a good predictor for states that are "at risk" of developing a nuclear weapons program. According to the authors, this evidence is contrary to the beliefs of many pundits who argue that diplomatic isolation is a determining factor of nuclear proliferation. (Editorial Note: North Korea is an important counter example.)
- A surprising finding is that states with a nuclear rival tend to refrain from nuclear proliferation. This supports the "…somewhat controversial arguments of proliferation 'optimists' that the fear of preventative war from nuclear rivals discourages the pursuit of proliferation." (Editorial Note: This statistical finding is inconsistent with major cases. It may be consistent with Egypt complying [despite Israel's presumed nuclear weapons, after Camp David and the bilateral peace treaty with Israel], with nuclear nonproliferation agreements, but not with the history of Pakistan and India, nor India and China, nor China and the USSR and U.S.)
- Also surprising is the finding that the democracy variable has a significant and positive coefficient in proliferation actions in what the authors call the "nuclear weapons possession stage." This indicates that democratic states are more likely to produce nuclear weapons provided they already have a nuclear weapons development program, supporting arguments that democratic states are more vulnerable to nationalist pressures.
- Out of the willingness variables related to security, the statistical analysis indicates that an external conventional military threat is the most significant determinant in nuclear proliferation. The results indicate that states which are facing a substantial conventional threat and have the requisite economic capacity are more likely to seek nuclear weapons.
- Finally, the major power status variable is the most potent determinant of nuclear proliferation. That is, recognized major powers and states that seek to be

recognized as major powers are more likely to have, or strive for, nuclear weapons programs than non-major powers.

Specific forecasts
None made.

Significant Points
In their concluding interpretation, the authors note that U.S. hegemonic status probably does more to proliferate nuclear programs and weapons than it does to stop them. Additionally, the authors' concluding comments seem to indicate that global perception is critical to nonproliferation. The authors write, "A strong policy of asymmetric nuclear deterrence may deliver the U.S. a world with few nuclear adversaries but at the risk of greater friction and possibly nuclear war [with the determined adversaries that remain]. Similarly, while a national missile defense system might make it harder for proliferators to directly challenge the U.S., states facing more proximate conventional threats…may still find that nuclear weapons are an appealing option in an uncertain world."

Other Major Conclusions and Unique Dimensions
The study was unique in that it used two dimensions of proliferation: opportunity and willingness. While many case studies are only one-dimensional, this multivariate quantitative analysis tries to account for the complexities of nuclear proliferation.

Conclusions
The authors draw the following conclusions:

- States facing major conventional military threats may seek nuclear weapons to counter them.
- Nuclear defenders discourage proliferation among protégés.
- States facing threats from other nuclear powers exhibit a lower propensity to pursue nuclear weapons.
- Major powers have been more likely to develop nuclear weapons programs than lesser powers.
- Regional powers are prone to develop programs but not actual weapons.
- Pariah states appear to be statistically neutral in terms of developing a nuclear program and a weapon.
- Democracy deepens proliferation if the nuclear weapons program is already in place.
- Leaders facing domestic unrest seldom seek the nuclear option.
- Membership in the NPT encourages states to maintain pledges of nonproliferation.
- Latent production capabilities increase the predicted probability of having a nuclear weapons program but not a nuclear weapon.
- The diffusion of knowledge and technology eases barriers to nuclear programs and weapons.

What Missile Proliferation Means for Europe

Anthony Seaboyer and Oliver Thranert
Survival 48, no. 2 (2006): 85-96

Commissioned By
Independent examination by the authors.

Purpose and Objectives
To evaluate the present, globally spreading, missile proliferation threat to Europe and to contribute to discussion of the means to address it. The key questions the authors seek to answer are:

(1) Given that NATO and the European Union are militarily active around the globe in the fight against international terrorism or in attempts to re-establish international order, will missile proliferation – especially missiles equipped with nuclear warheads – affect Europe's ability to act internationally?

(2) If hostile states achieve the ability to hit the European heartland with missiles, to what extent are deterrence, pre-emption, and missile defenses useful tools in response?

Timeframe Examined
Future.

Prevailing Context
The authors acknowledge that in the Cold War context, the main missile threat was from strategic ballistic missiles based in the former USSR and that in that era of strategic mutual deterrence, missile defenses came to be viewed as destabilizing. The authors frame this article in a post-Cold War context in which the spread of ballistic and cruise missiles to other parts of the world, with the capacity to threaten Europe from many different locations, creates a different set of instabilities and these alter the way in which the threat, and responses such as missile defense, should be understood. The authors are skeptical of the U.S. advocacy of missile defense, but are "reluctant proponents" of Europe undertaking limited missile defense preparations in their own interests.

Methodology
The authors make predictions about missile proliferation based on past and present economic and political trends. However, the authors specifically note that forecasting based directly from the past is inherently flawed for three primary reasons. The first is the lack of adequate and reliable intelligence. For example, intelligence is likely to be fragmentary and controversial, such as the case with North Korea. Second, states do not necessarily need to develop a missile program; they can simply buy them as in the case of the Saudi purchase of CSS-2 missiles from China. Finally, political factors play a substantial role in the nature of missile proliferation (i.e., political motivations may change, political systems may change, and states may lose assistance from foreign technicians).

Report Format

I. Current Status of Missile Proliferation
II. The Future of Missile Proliferation
III. Consequences for Europe

Key Projections/Forecasts

Motivations to acquire

- Though not specifically stated, it can be inferred that the authors believe from recent trends that potential proliferators are acquiring and will continue to seek to acquire and upgrade ballistic and cruise missiles because of their relatively inexpensive cost for long-range delivery and their perceived high political and military value for leverage against the U.S., NATO, and EU.
- They note that more than 75,000 cruise missiles are already in existence worldwide, although the bulk of these are relatively short-range anti-ship systems. The longer-range cruise missiles some proliferators are developing or acquiring, however, can be launched from a large array of platforms and can be tipped with a variety of warheads, including chemical, biological, and nuclear.

Regions/countries of greatest concern

- As suppliers: Russia, China, North Korea, and Ukraine;
- As recipients and users: Iraq and Libya (formerly), Iran, North Korea, Pakistan, Syria, and Saudi Arabia.

Specific weapon types (N, B, C, R, Delivery Means), to include new or non-traditional weapons/effects/production techniques/delivery means

- Adaptation of missile programs in proliferator states to employ U.S. GPS and Russian GLONASS systems for missile guidance and targeting.
- Ukrainian covert supply of 18 Soviet-era KH-55 (strategic air-to-surface) cruise missiles with potential range of 2,500-3,000 km, between 1999 and 2001, to Iran is the kind of illicit trade that may be conducted with proliferators from time to time.
- Storable (more stable) liquid fuel is increasingly in use for North Korean-derived ballistic missiles, circumventing previous warning time based on requirement to load fuel only when alert or possible launch was anticipated.

Acquisition patterns/trends

- Most of the proliferating ballistic missile programs in the developing world have been based on former Soviet-era Scud technology (short-range, liquid-fueled ballistic missiles), employing elongated fuel tanks and stage-adding adaptations (e.g., by North Korea, Iran, and Pakistan) to increase range, or (as evidenced in Iran) to attempt to retrofit solid-fuel engines in Scud-type airframes.
- Proliferation of solid fuel ballistic missile technology (i.e., from Russia and China) has gained ground in Pakistan and Iran, and even Syria (which obtained Russian

SS-21 short-range missiles and may have transferred some to North Korea to analyze the propellant).

- These trends will probably continue, but it is hard to project which countries will achieve what technologies and which systems will be available at what time. When it comes to missile proliferation, predicting the future directly from the past is almost always wrong.
- The authors note that changes in U.S. intelligence estimates push back the likelihood of North Korea and Iran developing intercontinental missiles from 2010 to 2020.
- As biological weapons (BW) gain significance, cruise missiles could become more important since they are better suited for aerosol dispersal than ballistic missiles.
- It will be a long time before states currently developing nuclear weapons will be able to miniaturize them for delivery by cruise missiles.

Specific forecasts

- Cruise missiles with enhanced capabilities will increasingly appear in the missile proliferating countries.
- Because the Missile Technology Control Regime (MTCR) is flawed, it can only slow proliferation, not stop it. The authors cite specific flaws such as non-members (i.e., North Korea) who continue to export missiles and technology, and the existence of missile technology export firms in new members such as Russia and, prospectively, China that disregard the MTCR guidelines.
- Europe cannot dismiss the possibility that in the medium-term, a Middle Eastern country whose interests oppose the West, such as Iran, will be capable of launching a missile that can target a location in Central Europe.
- Because missiles with a sufficiently long range to target countries in the West are expensive, it is likely that countries that shoulder these costs will also want to pursue acquisition of nuclear warheads, since use of conventional and/or chemical warheads on long-range missiles would not be cost-effective.
    - The authors propose that the above scenarios present three dangers to Europe: (1) the possibility of Tehran using missiles to attack Paris, London, or Berlin even though, the authors believe, the realistic probability of such an attack occurring is very low; (2) Iran attempting nuclear coercion against Europe – the probability of this occurring is also low because France and the UK already have their own nuclear weapons which serve as a sufficient deterrent, while most other Europeans can rely on U.S. nuclear protection through NATO; and (3) Iran could use the threat posed by its weapons to deter Europe from intervening on the side of the U.S. to fight regional aggression or a humanitarian outrage. The final danger is the most likely Iran-nuclear-and-missile threat scenario for Europe, according to the authors.
    - The authors cite another scenario, however, in the event Europe joins a future U.S.-led coalition in a high-intensity military operation in the

Middle East, analogous to the 1991 Gulf War. The adversary might use missiles with NBC to attack critical regional targets such as harbors, airports, and bases during the deployment of Western troops to raise the costs to the West in the hope of stalling or repelling a major intervention. Europe will need to "think hard" about the only three ways to lower those costs: deterrence, preemption, and missile defense.

- Alternatively, countries such as Syria and Iran might not want to provoke the West directly through military confrontation or by launching strikes first. Therefore, it could be likely that such states would support terrorist operations against Western interests in neighboring countries, as asymmetric warfare in their own defense against perceived aggression by the West.

Significant Points

- The face of deterrence has changed significantly. The relatively stable situation of the East-West conflict has gone. Regional conflicts may involve a dynamic quite different from the Cold War years. Proliferating countries may use their new status as nuclear weapons states to enforce interests and regional aims rather than only as a means of deterrence against outside intervention.
- If Europe is highly vulnerable to attack not only on its forces in the theater but also directly at home, then it will have to contemplate options of preemptive elimination of adversarial missile systems (which operations would be fraught with complexity) and of by attempting to build a shield against offensive missiles over Europe through the deployment of missile defense, which is currently under examination by NATO.
- Unless such defenses were effective against adversarial missiles, political problems in making European decisions might not be eased. Still, missile defense deployment – even on a limited scale – would affect an aggressor's calculations by imposing uncertainty as to expected damage.
- European indecision would not necessarily force U.S. indecision, but could be an influence.
- If deterrence fails, then European missile defense, even limited, would be the instrument of choice.

Other Major Conclusions and Unique Dimensions

This study fills a gap in European expert analysis – in open literature – of the implications of missile threats to Europe from the Middle East that could impair U.S./NATO collaboration against adversaries in that region. In the post-Cold War environment, Europeans have tended toward skepticism about the value of missile defense against emerging threats based on the proliferation of ballistic and cruise missiles. This article probes, in a subtle way, the dimensions of European security that could be improved by reexamining afresh, in the post-Cold War proliferation environment, the issues of deterrence, preemption, and missile defense.

Conclusions

The authors conclude that, "in the coming years, a small number of states will further develop their ballistic as well as cruise-missile capabilities." However, due to the technical and political factors, it is not possible to predict which countries will possess what types of missiles and when. Noting that the Proliferation Security Initiative (PSI) and MTCR can only slow proliferation and not completely stem it, the authors note that a European missile defense system should be considered to help protect Europe from a third-party's ability to restrain Europe from intervening in operations beyond NATO and EU member territories. Yet with only a moderate threat perception, tight budgets, and other military necessities, missile defenses can not be a political priority.

The Correlates of Nuclear Proliferation: A Quantitative Test

Sonali Singh and Christopher R Way
The Journal of Conflict Resolution 48, no. 6 (2007): 859

Commissioned By
Independently conducted by Sonali Singh of Bain and Company and Christopher R. Way of Cornell University.

Purpose and Objectives
To use a quantitative data set and methods to test and critique the findings in the existing qualitative literature on nuclear proliferation, which consists mainly of comparative case studies, and to provide an analytical complement to that literature. The authors believe the value of quantitative study is that it corrects the current literature's tendencies toward: under-emphasis on assessing countries that have never proliferated; overuse of deterministic methods rather than probabilistic methods; and leanings toward singling out mono-causal determinants of proliferation rather than understanding multiple determinants of proliferation. A related objective of the study is to show that nuclear proliferation is a continuum, rather than a dichotomy.

Timeframe Examined
1945-2000.

Prevailing Context
Conducted in 2004 amidst national missile defense (NMD) debates. Central to the context of the study, is the theme of perception. The authors conclude that whether or not a NMD increases proliferation or stems it is a matter of how other countries perceive the U.S. NMD system. For example, if a state views the U.S. NMD system as neutralizing to their own deterrent capability, they may be spurred to acquire larger nuclear arsenals.

Methodology
The authors used survival models and multinomial logistic regression to test hypotheses from three broad approaches to nuclear proliferation. These approaches to nuclear proliferation are characterized as: technological determinants; external determinants; and internal determinants. Technological determinants of nuclear proliferation emphasize the role of economic development. External determinants emphasize conditions relating to the overall security environment. Internal determinants emphasize a range of domestic factors (political and economic).

The survival, or event history, models offer several advantages, most notably their suitability in handling rare events and their ability to model the effects of time. Additionally, the survival models allow for explanatory variables which change in value over the observation period.

Report Format

The study was organized under the following framework:

Overview of the three types of proliferation literature:

- *Technological determinants*: Technology is the driving force behind proliferation. Once a country develops a latent technological capacity to build nuclear weapons, it is only a matter of time before that country will develop nuclear weapons.
- *External determinants:* According to the authors, the external determinants literature emphasizes a state's willingness rather than capacity to build nuclear weapons. The threat environment is a driver of proliferation; that is, as the threat environment increases, so will the likelihood of a state pursuing nuclear weapons.
- *Domestic determinants:* The domestic determinant literature emphasizes the role of internal politics and economy on a country's decision to pursue or to not pursue nuclear weapons.

Proliferation data

- Dependent variables (multivariate)
  - *First explosion/ assembly of weapon*: Any country that has exploded a nuclear weapon or has assembled a nuclear weapon is considered to be a proliferator.
  - *Pursuit of weapons*: Countries that have pursued nuclear weapons are considered to be proliferators from the year of that country's first effort.
  - *Exploration of weapons*: Countries are coded as proliferators from the year they begin considering nuclear weapons.
  - *No interest*: Countries are coded as non-proliferators of nuclear weapons.
- Explanatory variables
  - *Technological determinants:*
    - Gross domestic product per capita
    - Industrial capacity index (binary)
    - Energy, electricity, and steel production and consumption
  - *External determinants:*
    - Enduring rivalry: Binary variable indicating whether or not a state was involved in one or more enduring rivalry in a given year.
    - Frequency of dispute involvement: Uses the militarized interstate dispute dataset to calculate a 5-year moving average of the number of militarized interstates per year a state was involved.
    - Security guarantee: Measure of defense pacts.
  - *Internal determinants*
    - Democracy and democratization: Uses Polity IV data to create variables relating to regime type and proliferation.
    - Economic interdependence and liberalization: A measure of exposure to the global economy.

- Status inconsistency/ symbolic motivations: Measures a countries "prestige deficit" and countries dissatisfaction with the international status quo.

Methods and Results

Key Projections/Forecasts

Motivations to acquire

- The decision to seriously explore nuclear weapons
  - The results indicate that a country's decision to explore nuclear weapons seriously is most affected by GDP per capita and industrial capacity. This supports the theory that at low levels of GDP, steady economic growth increases the likelihood that a country will pursue nuclear weapons. The inverse is also true. At high levels of development, countries are less likely to pursue nuclear weapons.
  - Due to low significance levels, the results offer little support to the claim that alliances with great-powers provide threatened states with a substitute for nuclear arms.
- The decision to acquire nuclear weapons
  - By and large, the authors' results suggest that the commonsense theory of nuclear proliferation may have more weight then previously thought. That is, states decide to "go nuclear" when they are faced with a security threat that cannot be overcome by other means.

Specific forecasts

The authors presented the following probabilities:

TABLE 3
Substantive Effects of the Explanatory Variables
on the Likelihood of Exploring Nuclear Weapons

	Percentage Change from Baseline Hazard Rate	
Variable	*Explore*	*Acquire*
Great-power military alliance	-49	-64
Participation in ongoing enduring rivalry	+382	+743
Increase in frequency of MIDs (two more/year)	+38	+52
Industrial capacity threshold	+563	+2,340
Increase in trade openness	-72	-2
Increase in per capita GDP - $500 at very low level	+26	+12
Increase in per capita GDP - $500 at high level	-20	-17
Satisfaction	+40	-82
Increase in democracy	+25	+94

NOTE: MID = militarized interstate dispute; GDP = gross domestic product.

For example, a country with a great-power military alliance has a hazard rate for exploring a nuclear capability that is 49% lower than a similar country without an alliance, as well as a 64% lower risk of acquiring a nuclear weapon.

The following table lists countries that had a high predicted hazard rate for exploring nuclear weapons, but never actually did so:

Country	**Years of Maximum Predicted Hazard**
Saudi Arabia	Mid 1980s – mid 1990s
West Germany	Mid 1950s – early 1960s
Japan	Mid 1950s – 1960s
Yugoslavia / Serbia	1950s – 1960s
Turkey	Late 1960s – 2000
Bulgaria	1950s
Spain	1960s – early 1970s
Greece	1960s & 1980s
Italy	1950s – early 1960s
Syria	Various

The authors note that it is no surprise that Japan and Germany were predicted to have high hazard rates for exploring nuclear weapons because of their high levels of economic development and strong security threats that they face.

Significant Points

The authors emphasize the need to move beyond the "…search for deterministic, univariate accounts of proliferation decisions…" Thus the authors remain sensitive to the diverse stages of proliferation by using multivariate indicators of nuclear proliferation. For example, the dependent variable was not simply a dichotomous "proliferate" or "not proliferate" variable, but three separate measures. Additionally, the study is unique in that the authors' findings and conclusions do not vary widely from conventional wisdom on nuclear proliferation. The authors state that the results suggest that, "…contrary to what some scholars have argued, existing arguments about the determinants of nuclear weapons proliferation do a reasonable job of accounting for the data."

Other Major Conclusions and Unique Dimensions

In conclusion, the authors note that existing theories deserve more credit than they are frequently given. In this respect, it is the authors' intention to complement previous empirical analyses of proliferation by providing a dataset on nuclear weapons proliferation to test theoretical arguments. The following actions are proposed to reduce a country's likelihood of pursuing nuclear weapons: (1) reduce the threat posed by external environment; (2) accelerate economic growth beyond the threshold of temptation; (3) integrate into the world economy; and (4) forge a defensive alliance with a nuclear power.

Section VI: Contemporary Sources

Block, Steven. "Living Nightmares: Biological Threats Enabled by Molecular Biology." In *The New Terror: Facing the Threat of Biological and Chemical Weapons*, edited by S.D. Drell, A.D. Sofaer and G.D. Wilson. Stanford: Hoover Institution Press, 1999.

Campbell, Kurt M., Robert J. Einhorn, and Mitchell B. Reiss, eds. *The Nuclear Tipping Point*. Washington, D.C.: Brookings Institution Press, 2004.

Cirincione, Joseph, Jon Wolfsthal, and Miriam Rajkumar, eds. *Deadly Arsenals: Nuclear, Biological, and Chemical Threats*. 2nd ed. Washington, D.C.: Carnegie Endowment for International Peace, 2005.

Davis, Jim A., and Barry R. Schneider, eds. *The Gathering Biological Warfare Storm*. Westport, Connecticut: Praeger Publishers, 2004.

Dunn, Lewis A. "The Changing Face of Proliferation: Some Thoughts, Speculations, and Provocations." In *CSIS-Sandia Workshop on Changing Face of Proliferation*, 2005.

"Executive Summary: Report of the Commission to Assess the Ballistic Missile Threat to the United States." In *Rumsfeld Commission*: U.S. Congress, 1998.

"Foreign Missile Developments and the Ballistic Missile Threat through 2015." In *National Intelligence Estimate*. Washington, D.C.: National Intelligence Council, 2001.

Geissinger, Jackie, Michael George, Tim Miller, and Forest Waller. "Emerging Weapons of Mass Destruction Technologies: Impact on the Air Force." In *AF Futures Project*: U.S. Air Force, 2003.

Giles, Gregory F, Eleanore Douglas, Todd Koca, and Tom Skypek. "Thwarting an 'Evil Genius': Summary of Workshop Proceedings." In *Thwarting an Evil Genius Workshop*. Washington, D.C.: SAIC and DTRA, 2006.

Jo, Dong-Joon, and Erik Gartzke. "Determinants of Nuclear Weapons Proliferation." *The Journal of Conflict Resolution* Vol. 51 No. 1 (2006): 167.

Jones, Rodney, ed. *Tracking Nuclear Proliferation, a Guide in Maps and Charts*: Carnegie, 1998.

Liebert, Mary Ann, and James B. Petro. "Biotechnology: Impact on Biological Warfare and Biodefense." *Biosecurity & Bioterrorism* Vol. 1 No. 3 (2003): 161-68.

Lugar, Richard G. "The Lugar Survey on Proliferation Threats and Responses." Washington, D.C.: U.S. Senate, 2005.

"Mapping the Global Future." In *NIC 2020 Project*. Washington, D.C.: National Intelligence Council, 2004.

Seaboyer, Anthony, and Oliver Thranert. "What Missile Proliferation Means for Europe." *Survival* Vol. 48 No. 2 (2006): 85-96.

Singh, Sonali, and Christopher R Way. "The Correlates of Nuclear Proliferation: A Quantitative Test." *The Journal of Conflict Resolution* Vol. 48 No. 6 (2007): 859.

"Special Issue: Nuclear Weapons Proliferation: 2016." *The Nonproliferation Review* Vol. 13 No. 3 (2006): 617-25.

Whiteneck, Daniel J. "Global Evolutions and the Role of Nuclear Weapons: Alternative Futures for the Next Decade." In *NIC 2020 Project*. Washington, D.C.: The CNA Corporation, 2004.

Wilson, Thomas R. "Global Threats and Challenges through 2015." edited by Defense Intelligence Agency. Washington, D.C.: Senate Armed Services Committee, 2001.